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ADDRESS AT THE ANNUAL GENERAL MEETING

of the Society, held on 24 June 1946, by the President

THE RIGHT HON. THE LORD RENNELL OF RODD

K.B.E., C.B.

YOUR SOCIETY has suffered sad and heavy loss in the death of two Honorary Corresponding Members, three Gold Medallists, and seventy-two Fellows during the past year. In the death of Lord Plender, who for ten years held the office of Honorary Treasurer of the Society, we have lost a great supporter and wise counsellor in many fields. The death of His Excellency the late Belgian Ambassador, Baron de Cartier de Marchienne, has deprived this country and this Society of a true friend. Three past members of Council have died during the year: the distinguished zoologist, Professor J. Stanley Gardiner, F.R.S.; Mr. Oliver Bury, member of Council 1921–25; and Colonel C. H. D. Ryder, who was awarded the Patron's Medal for 1905 for his survey of Yunnan and for his valuable work in connection with the late Sir Francis Younghusband's expedition to Lhasa in 1904. Sir Ahmed Hassanein Pasha, the distinguished Egyptian explorer and statesman, was killed in a motor accident in Cairo in February: he was elected Honorary Corresponding Member of the Society in 1924 and a Gold Medallist in the same year. The death of Edward Reeves in October last year, in a sense marked the end of a period in the history of the Society. He had been for thirty-three years, until his retirement in 1933, Instructor in Surveying and Map Curator. During his long years of service, Edward Reeves advised and instructed many famous explorers, including Captain Oates, Sir Ernest Shackleton, Miss Gertrude Bell, H. G. Watkins, and J. H. Rymill. He formed a link with the great figures of nineteenth-century exploration, having known in his early days, among others, H. M. Stanley, Sir Richard Burton, and Sir Leopold McClintock.

You will see from the Annual Report of your Council that most of the Staff of the Society have returned from the Services to their work here. Mr. Fawcett Allen, our Map Curator, retired at the end of 1945, unhappily on

grounds of serious ill-health, after fifty-two years' service. The post of Map Curator has now been combined with that of Librarian in the person of Mr. Crone. Since our last annual meeting Mr. L. P. Kirwan has been appointed to succeed the late Mr. Hinks as Secretary of the Society. Mr. L. P. Kirwan, who took up the appointment in November of last year, is a distinguished archaeologist with considerable field experience in Egypt, the Sudan, Arabia, and England. He had a no less distinguished war record of service in the Army, latterly in the Offices of the Cabinet. Your Council have now decided, in view of Mr. Kirwan's contributions to and work for the Society already in the brief first year of his office, to appoint him Director and Secretary of the Society in accordance with the recommendation made in 1939 by a committee under Sir Francis Younghusband to consider the future organization of the Society and the functions of its officers. There have been two other new appointments: Mr. Alfred Stephenson, lecturer in Survey at the City and Guilds College, has been appointed part-time Instructor in Survey; and Miss Ann Parry—a descendant of the Arctic explorer Admiral Parry who was one of the original members of the Raleigh Club from which this Society sprang—is at present filling the post of Assistant Editor of the *Journal*. She succeeds Mrs. Rowley, whose excellent work in that post deserves special tribute.

The more detailed work of your Council has in the course of this session been delegated to Committees of Council on finance and administration, research, publications, and the library. These committees, now endowed with greater powers and responsibilities, report to Council through their Chairmen who are members of Council, but their composition includes Fellows who are not members of Council. This system enables the Council and its committees to get through a great deal more work than hitherto and to cover a wider range of subjects as befits the extended work of the Society.

One or two innovations have been made in the Society's House: I trust they will prove acceptable to Fellows. By the purchase of fifty portable chairs and a little improvisation, we can now quickly transform the New Map Room into a small lecture theatre, convenient for use by discussion groups and more suitable than our main Hall for the small audiences of experts who normally attend the technical afternoon meetings. We are also, at small cost, converting one of the rooms not previously used by Fellows into a film-viewing and editing room for the use of Fellows and others who wish to perfect their films before showing them to the Society. In addition to the Society's activities, the building houses the Permanent Committee on Geographical Names, an official interdepartmental body, as well as, temporarily, the British Glaciological Society.

I have felt for a long time that these spacious and commodious premises should house or give temporary accommodation to other geographical and related activities. I cannot help thinking that the multiplication of societies and associations with similar or allied objectives, entailing in each case expenditure on housing, administration, heating, lighting, and domestic economy, is not warranted to-day and that greater good would be served by a concentration of like activities in centres where economies in these fields can be effected. I believe these views are shared by His Majesty's Government and the Royal Society, and I for one desire to do all I can to help

in this matter. I therefore think it right that any and every such scheme, provided that it is designed to further geography and related subjects, should be carefully considered by your Council. The price may be some compression of space, but if in this way the Society's house is used to the better advantage of geography as a whole, as a centre of study and accommodation, the main purpose of our organization will be fulfilled.

Geography, perhaps least of all the branches of science, can, or should be, isolated. Every definition of geography that I have seen connotes some relationship with one or more other branches of science. Geography as the knowledge of the habitable globe, postulates at least a knowledge of Man who inhabits it; and if man, then also how he lives, what he lives on, and why he lives where he does. So we come inevitably to human geography, botanical and zoological geography, and to social, economic, political, and historical geography. As a background to these, are mathematical geography and geodesy with the closely related investigation of the earth's crust. All these are in the field of geography and so in the field of the Royal Geographical Society. None of these ought to be passed on one side, and I like to hope that none will be omitted from the activities of the Society. But as the horizon expands and specialization inevitably and rightly sets in, so is the need for sympathetic coordination more than ever required. That is a function which I want this Society to have. That is what I have sought to preach and practise since I had the honour to be elected President last year. As you have been good enough to propose me for a further term of office, that is the line I propose to pursue as long as you wish me to remain. But I must warn you that this policy involves some changes and even breaks with the past. I believe them to be right: it will be for you to judge.

The first of the consequences which come from this point of view is that academic geography and research work in the library and at the desk must play their part in parallel with, neither excluding nor being excluded by, work in the field. The field is to geography what the laboratory is to the physicist, but all the work of the latter is not done in the laboratory. It is also done at the desk and in the Schools of Physics in the Universities. So geography in the field must have its relations with the teaching of geography and with the machinery for collecting and publishing results. I hope the Society will play its part as a forum, contributing to the publication of research, facilitating the interchange of ideas, as well as helping and encouraging work in the field.

Some of the first fruits of this attitude of mind about geography, which my colleagues on the Council share with me, are, I hope, already visible in the papers read before the Society in the Session which has just closed. The lectures have covered a range of subjects, formerly never, or scarcely, touched on by the Society. In the first place, a number of papers have dealt with the work and exploits of personnel serving in the armed forces of the Crown during the World War in strange and difficult places or circumstances. Some of these addresses have ranged over ground which is not strictly speaking geographical in the older fashioned and narrower sense, but they have all contained a great deal of geography in the sense I have described. They have incidentally brought to the notice of those Fellows who were not serving in the armed forces or had no share in the wider panorama of war, some of the

magnificent achievements in various parts of the world of our naval, military, and air arms. Much of the material in these papers was made public for the first time in this Hall.

A second group of papers, both evening and afternoon, has dealt with geography in its increasing contact with other sciences, both human and natural. Among these papers, which are supplemented by matter published in the *Journal* and not delivered *viva voce* in the Society's House, will I hope be found material of interest to lay and academic geographers alike, as well as to travellers and scientists who are not particularly or essentially concerned with the work of your Society. If one or other of these papers does not interest you in particular as an individual, please remember that there are others who are interested and will be grateful for the material.

Finally I come to the third group of subjects dealt with, namely exploration and scientific geographical material collected in the field. Here, a very great deal has been done during the war, but not all of it, and not all the persons concerned, have been available to the Society. We expect to have more of it as people return to this country, as communications become easier, and as it becomes possible for your officers, and even government departments themselves, to ascertain what was done and by whom it was done. We shall not of course in the future neglect this aspect of geography in the field, any more than we have done heretofore, though travellers who merely wish to use the Society as a forum to tell the world where they have been will not find any readier welcome than they have in the past.

One of my troubles as your President, and much more so that of your Secretary, has been not how to find material to present to you, but how to select the material available. We have no doubt erred in the view of many of you, but bearing in mind what I have said, we ask you to help us to give you what you want to hear and read. We have therefore decided to send out to Fellows a questionnaire so that we can have the views of those able to attend meetings. They will be carefully noted; but if *your* views are not met in full, please remember that others may have given different opinions. The questionnaire will also deal with times of meetings. In replying I would ask you to have ever present in your mind that the burden of long hours on the staff of the Society is already very considerable. We are very grateful to the staff for what has been done during the past year. What you see or hear is not the end of what the staff has done or is doing. An exhibition or a lecture means a lot of preparatory work and a lot of cleaning up afterwards. A great deal of the rehabilitation of the building, and the rapid resumption of the Society's activities, is due to what may be called the voluntary overtime of enthusiasm and devotion to work which is measured neither in man-hours nor in money.

I would now like to draw your attention to some special aspects of the Society's activities and to some proposals for future development. Since expeditions will tend to become increasingly specialized, we intend to develop tuition in surveying to meet the needs of the specialist rather than of those who require a wider training in the subject. In general, we hope that our training will enable the candidate not only to carry out field work but also to work up his results. But this teaching must be individual, and while in each case certificates of proficiency will be awarded to a standard to be

decided by our special survey committee, general courses will probably not be possible. In this context our most pressing problem is the provision of new instruments.

Another possible development to which I should like to draw your attention is a considerable increase in the number of geographical and travel films displayed. We have sought the views of Fellows on this in the questionnaire to which I have just referred. Hitherto, films shown to the Society have been almost exclusively amateur films, often of high quality, taken by Fellows abroad. During the war years the development of the documentary film for educational and other purposes has made great strides. Next session, we propose to include in our film programme many such films illustrating the activities of man in his geographical environment, not only abroad but in our own country. We are trying to procure modern sound apparatus for our Hall, so that our film facilities may be as complete and as up to date as possible. I would like here to stress what has been pointed out by geographers before, but is still too little realized, that our knowledge of the features of the earth is not complete until we have a description of their beauty. To record that beauty, through photography, through words, or through painting, is as much the business of the geographer as the making of a survey of it.

In the research and educational field we propose to help meet the need of geographers by publishing memoirs too long and too technical for inclusion in a periodical. We intend to make a Special Research Series of Publications, similar in style and format to the *Geographical Journal*. They will be available to Fellows at a reduced cost. We have also already inaugurated a series of outline pamphlets on geographical subjects for use by schools and educational institutions. The first of these, on "The making of a map," by our Honorary Secretary, Brigadier Sir Clinton Lewis, has already appeared and will, we hope, be followed by others on the principles of air survey, the spelling of place-names, and so on.

The map-making activities of the Society have naturally been strictly limited owing to the absence of all but one draughtsman on service with the Royal Air Force. With the return of the staff, this important and characteristic activity of the Society will quickly revive. But even during the war, further progress has been made with the compilation of the aerial map of the southern slopes of Mount Everest, and in the course of the year the Arabic edition of the British Council map of Europe and the Middle East was produced and distributed to the Arab rulers and Governments who have received it with considerable enthusiasm.

It may be relevant here to mention, in connection with those Arab countries generally grouped under the misleading term "Middle East," that your Council—and in particular one of your Vice-Presidents, Mr. Keeling—has made strenuous efforts to persuade His Majesty's Government to reconsider the present use of this term. My predecessor, Sir George Clerk, pointed out in his Presidential Address last year that there is general agreement between British and American geographical authorities that the Near East should be understood to comprise the Balkans, Turkey, and the lands of the Eastern Mediterranean, namely, Syria, Egypt, and Transjordan; while the Middle East should include 'Iraq, Persia, Afghanistan, and the Arabian

Peninsula. The Prime Minister was approached on the subject, but he pointed out that the present use of the term "Middle East" had in fact crystallized into accepted practice as comprising at least the area of Egypt, Palestine, Cyrenaica, Syria and the Lebanon, Transjordan, 'Iraq, and the Arabian Peninsula, as well as, in most cases, Persia and Turkey. He therefore felt that to make any change in official nomenclature at this stage would be difficult and might lead to considerable confusion. Although the reply, from a geographical point of view, is not satisfactory, you will, I am sure, approve of your Council's action in making these representations in the interests of geography.

In addition to the evening, afternoon, and film meetings, your Society has made a beginning in mounting exhibitions of geographical interest in the House. These started in October with an exhibition of captured German maps. During the Christmas holidays we mounted an exhibition of Maps and Map-making, including a display of early maps, and practical demonstrations of map-making with instruments and equipment from the Army and Ordnance Survey. This exhibition proved very popular. So in March, in cooperation with the Air Ministry and the Ministry of Supply, we held a more ambitious exhibition of Air Photography and Air Survey work and equipment, the latter including the most modern instruments, many on general view for the first time. This exhibition was visited by some nine hundred people, among them many foreign Air Attachés and air missions. In April, in conjunction with the Royal Photographic Society, we held an exhibition of Geographical Photographs, the bulk of which came from your Society's collections. Your Council propose to continue this development with further exhibitions of this sort in many fields of geography. I should like to think that at least one exhibition can be arranged to coincide with the beginning or end of each of the three scholastic and academic holidays for the benefit of students and teachers as well as for the Fellows, their friends, and the general public. I look to you to bring these exhibitions, and indeed all the activities of the Society, to the notice of your friends. I cannot promise to send out circulars and notices on every occasion when something of this sort is impending, because the cost of doing so is to-day too high. To send one letter to every Fellow costs in postages and stationery alone nearly £50. So I ask not only for your charity but also for your help in overcoming these difficulties.

The *Journal* itself suffers from two very great limitations at the moment: the amount of paper available, and the cost of printing and publication. Due largely to these difficulties, the whole future of the *Journal*, both as regards frequency of issue and as regards the type of periodical which would be most welcome to the majority of our Fellows, is and will continue to be under active review by your Council. The greatest limitation in the size of the *Journal* has been the steady rise in printer's costs as compared with pre-war years. This rise is likely to continue. The amount of material which we can publish is thus strictly limited, and may remain so for some time. Within those limitations we have a *Journal* which I gather by common consent has maintained its standard worthily. I would like to see the correspondence column and the *Monthly Record* developed to cover current geographical work as well as the geographical activities of societies and associations and Univer-

sities in all lands. The *Journal* now also includes a bibliographical list of accessions to the Library and Map Room.

There have been a number of additions of considerable importance to the antiquarian side of the Society's collections during the past year, the most notable of which have been: an exquisitely illuminated Portolan atlas by Battista Agnese, dating from the middle of the sixteenth century, presented by the Trustees of the late Mrs. Yates Thompson; two sixteenth-century manuscript charts and other atlases, obtained with the Goodenough Bequest and the generous assistance of Major Melville Lee; and a volume containing one hundred and forty maps by Faden, Arrowsmith, and others, presented by Major G. St.J. Orde Browne.

The income and expenditure account, and the balance sheet of the Society and its trust funds, are before you. To replace the late Lord Plender as Honorary Treasurer, we have been fortunate in securing Lord Catto of Cairncatto, the Governor of the Bank of England, whose advice and wisdom will be of obvious benefit to the Society. You will not need me to tell you about Lord Catto or his inestimable services to the Empire over many years of public and private life. I think you will agree that under his supervision the finances of the Society could not be better administered.

The financial position, while not unsound, looks more satisfactory than it really is. It is true that during the war years the Society enjoyed an income greater than its expenditure and has thus been able to accumulate a small reserve; this has been well invested in government securities which have shown considerable profits on realization or on current market values. But this excess of income has been due to the curtailment of many of the Society's activities and the absence of many members of the staff on service with the armed forces. With their return, the increased emoluments to which they were entitled and which they have been given, and with all costs so much higher to-day than in 1939, the apparent prosperity of this Income and Expenditure account is quite illusory. Practically everything else has increased in proportion except the entrance and annual fees. We have decided to set aside from current income and invest the life composition fees because they involve a liability for continuing service to the Life Fellows. The number of Fellows compounding their annual fees involves however a considerable loss to current income and of course a continuing loss. It is mainly this acceleration in the practice of compounding annual fees which has impelled us to adopt the policy described.

We have had a small increase in the grant from His Majesty's Government which is very welcome, and I sincerely hope that when the full impact of current expenditure is visible in the accounts the Lords Commissioners of His Majesty's Treasury will see fit to recommend to Parliament a further increase consistent with the rise in costs as compared with 1939 and with the increased contribution which your Society is making to public knowledge in the advancement and interpretation of geographical science.

I would like particularly to refer to one valuable source of support for geographical research and exploration, and that is the *Geographical Magazine* Trust Fund. The close cooperation between the *Geographical Magazine* and the Royal Geographical Society and the support the Company give to

geography is not sufficiently realized. Under the terms of a Trust Deed, the Company has undertaken the legal obligation to assign one half of all profits distributed by way of dividend or bonus to a fund for the advancement of geographical exploration and research and the promotion of geographical knowledge. The major part of this money, which does not of course come into the Society's coffers, has already been allotted by the Trustees to various objects for the advancement of geography; namely, *inter alia*, to institute a Travelling Fellowship for geographical work in East Africa; to defray the cost of publication of research memoirs; to develop the geographical film activities of the Society; and to meet some of the expenses of distinguished foreign geographers invited to lecture in this Hall. You will, I am sure, appreciate the valuable assistance thus given by the *Geographical Magazine* Company towards the promotion of the objects of your Society.

As you are aware, to-day the cost of any scientific expedition is inordinately high. The financing of major expeditions is at long last beyond the scope of the Society and in the future will probably have to be met from public funds in one form or another. But that is no reason why the Society should not contribute, as I think it should, both to such and to minor expeditions with the object of furthering geography. I envisage such contributions taking the form of grants for special work in the field or in publishing material collected, in association with major expeditions having primarily general or even non-geographical objects. I also and especially want to see small expeditions helped with grants, instruments, and moral support as we have done in the past. But this help will not be limited to field work; the publication of material if less romantic is just as important and is frequently more difficult for the smaller parties to achieve, since one frequently finds that they have spent all they had when they come back to this country (or even before) and have no resources left to pay for working up or publishing the fruits of their labours. Here may I say to would-be critics of the cost of administration of the Society that the staff is currently and continuously engaged on precisely this work, and that is one of our major if less spectacular contributions to geography in the field. But I want yet more done, and that means more money.

My predecessor referred to the Andrews Bequest for the furtherance of cartography. The major part of this bequest has now been received, and is to be used to assist students interested in the subject and, in general, to further cartographical work.

From our late Honorary Treasurer, Lord Plender, we have received a most welcome legacy of £5000, and the late Mrs. Gertrude Stanbury has generously bequeathed to the Society a legacy of £500. These bequests were received too late for inclusion in the accounts now submitted.

The essential factor in the financial situation of the Society is and will remain the number of Fellows. The Fellowship is again, I am glad to say, increasing, but I shall not be happy until I see the total number of Fellows increase to well above the pre-war figure. If all the Fellows in this country would make it their task to propose one new Fellow during this coming session, we should be well on our way to my goal. Included with a forthcoming number of your *Journal* you will find a proposal form for a candidate suitable for election.

In these days of political friction, the need to strengthen ties of cultural and scientific association with foreign countries assumes an added importance. Individually and corporatively we can all contribute our help in this. The task of the Society, in particular, is great and well understood by your Council. As a first step in the resumption of post-war contacts with foreign geographical societies, your Secretary and I have visited the geographical societies in Norway, Denmark, and Sweden. A member of your Council, Professor Austin Miller, has resumed contact on behalf of the Society with the Netherlands Geographical Society.

Meanwhile, we have reopened correspondence with many other geographical societies and institutions in all parts of the world; notably with those in France, Belgium, and Hungary, in the Soviet Union, in Canada and other countries of the Commonwealth, and in both North and South America.

At home, too, we have by personal visit or by letter established close relations with the Royal Scottish Geographical Society, the Manchester Geographical Society, and with a number of University centres of geography.

I am sure that you will agree with me that the establishment of close relations with kindred associations and geographical bodies both at home and abroad should continue to form an important item in the present and future expansion of the Society's activities.

I must apologize to you all for the length of my address, but in this, the first post-war year of the Society's activities, I have thought fit to review not only what the position of the Society is, but what its setting in the field of post-war geography, as I conceive it, should be. We are here in the Society as in so many other fields at the crossroads of the progress and regress of life, with its ever-expanding horizons born of scientific advance and discovery. Here as elsewhere it is for us severally to choose whether we shall grow or decay, whether we shall live or die. It is not for one of us to decide for all; it is for each of us to decide this thing, and in deciding to have in mind the needs and desires of others before which our personal predilections are unimportant.

THE ARCTIC FLIGHTS OF *ARIES*

Wing Commander D. C. McKINLEY, D.F.C., A.F.C.

Evening Meeting of the Society, 17 December 1945

IN MAY 1945 the Royal Air Force Lancaster *Aries* made a series of flights in high northern latitudes, during which the North Geographical Pole was reached and two magnetic survey flights were made in the region of the North Magnetic Pole. To do full justice to the complete findings of the expedition would take too long, and I therefore propose in this paper to give only a general account of the flights, while the first official report is being prepared.

My own interest in the expedition dates back to 1942, when both Wing Commander Maclure of the Royal Canadian Air Force and I were at the Central Navigation School at Cranage. Maclure had then already written a paper on orientation and navigation in high latitudes, in which he proposed a new and simpler method of orientation, which he named the Greenwich Grid System. He was most anxious to have practical experience of actual navigational conditions in the Arctic and to try out his proposed system, while I was keen to make a fuller study of general flying conditions in the same area. The humble Anson with which the School was then equipped was of course totally unsuited to the task, and the Air Ministry could not hold out any prospect of releasing a long-range aircraft for experimental work such as this. So for the time being the project had to be shelved. It was not until the closing months of 1944 that a single Lancaster—the *Aries*—was offered to the School, which had by then moved to Shawbury, where it was known as the Empire Air Navigation School. A proposal for a series of flights over the Arctic basin was then placed before the Air Ministry. During the last few days of 1944 consent was given to the outline plan, and the Empire Air Navigation School was charged with the task of preparing the expedition.

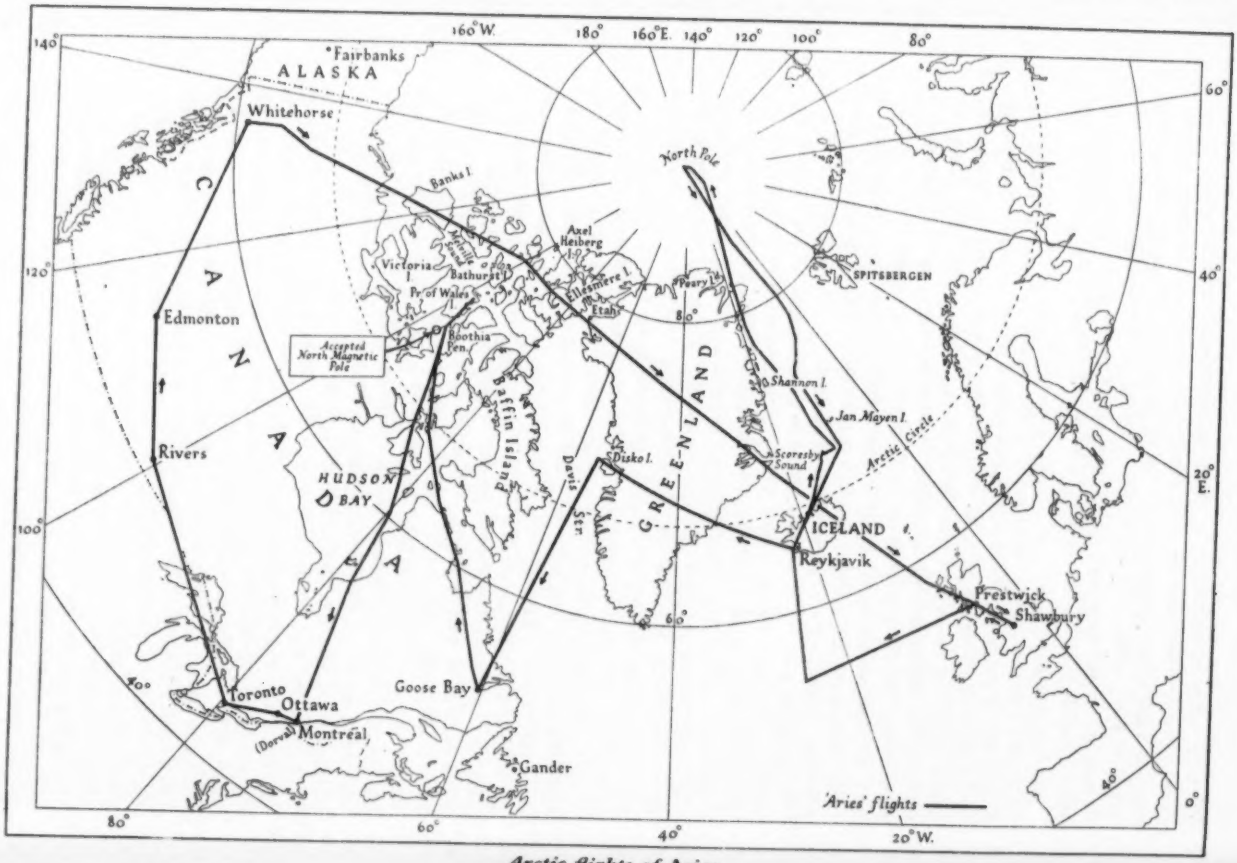
The *Aries*, which in December 1944 had completed the first R.A.F. round-the-world flight, could not be spared immediately for the modifications needed to fit it for its new task. However, in the early spring of 1945 several fairly extensive alterations were made to the body of the aircraft, including removing camouflage, armour, and armaments, streamlining the nose and tail, and increasing the tankage to give a range of about 5000 miles. Meanwhile the crew was chosen and the detailed planning of navigation, flying technique, maintenance, medical surveillance, and emergency measures was completed. The initial preparations included a series of "mock-up" flights in a synthetic trainer (the Celestial Link Trainer), in which it was possible to simulate all the known navigational problems of the Arctic. The pilots made a careful survey of all existing Arctic records, and studied the effects of temperature on flying technique, the conditions affecting possible forced landings, and so forth. Wing Commander Winfield, the medical officer of the party, had the seemingly impossible task of finding suitable clothing, food, and "survival equipment" to meet the many contingencies which might arise.

Clothing had to be sufficiently compact to allow freedom of movement in an already overcrowded aircraft, cool enough to prevent overheating, and yet warm enough to give protection in case of a parachute descent or landing in Arctic waters; ordinary flying clothing would probably have meant death through exposure before reaching the ground. The preparations also included living in an ice chamber and eating dehydrated meals for a period of two days before our departure.

The aims of the expedition as finally planned were as follows: to test the Greenwich grid system of orientation; to make a magnetic survey in the area of the Magnetic Pole; to examine the possibilities and limitations of navigational teamwork under the peculiar conditions imposed by Polar flying; to examine the behaviour of automatic dead-reckoning gear and navigation instruments, paying special attention to compasses; to collect meteorological data; to take photographs of Arctic topography; to test the possibilities of radar mapping of the icefields; to observe the effects of Polar flying on aircrew efficiency; and to collect engine and airframe data.

One major problem was the menace of icing, against which we took the minimum necessary precautions. Fully to equip the aircraft against all the dangers of icing would have added very considerably to the time needed for preparation. After careful consideration of probable weather conditions over the Arctic, it was assumed that stability would be reached at heights above 8000–10,000 feet; or at least that the temperature ranges would be sufficiently low to eliminate the risk of icing except in the lower layers. We planned to fly at some 15,000 feet, where we expected an average temperature of about −30° C. In practice, the average temperature proved to be about −34° C. at that altitude. Providing personal warmth was another problem. We could not resort to hot air heating because of the resulting condensation and freezing up of observation windows. To provide electrically heated clothing for every member of the crew would have meant too great a load on the aircraft's electrical system, as well as seriously restricting individual movement through each of us being anchored to the aircraft by electrical leads. Instead we resorted to several layers of light clothing, and when any person in the rear of the aircraft became excessively cold he was brought forward to the flight deck, where the sun's rays were concentrated through the perspex cockpit canopy. Excess oxygen was also used as a body-heating element.

The aircraft was manned by a crew of eleven, made up as follows. As captain, I was in charge of the expedition and, with my second pilot, alternated between flying the aircraft and acting as engineer, photographer, and meteorologist. The first navigator was responsible for all external observations; the second navigator for all radar observations and the instantaneous plotting of the aircraft's position. The research officer was responsible for the magnetic survey. The two wireless operators took turns on radio watch and made a study of radio phenomena. The medical officer, apart from his own work as medical observer, was in charge of the emergency and rescue equipment and also helped the research officer in his very full task. The remainder of the crew consisted of a maintenance team of three who were responsible for keeping the aircraft in full flying trim. It is worth noting that both pilots and the research officer, as well as the two navigators, were all navigation specialists.

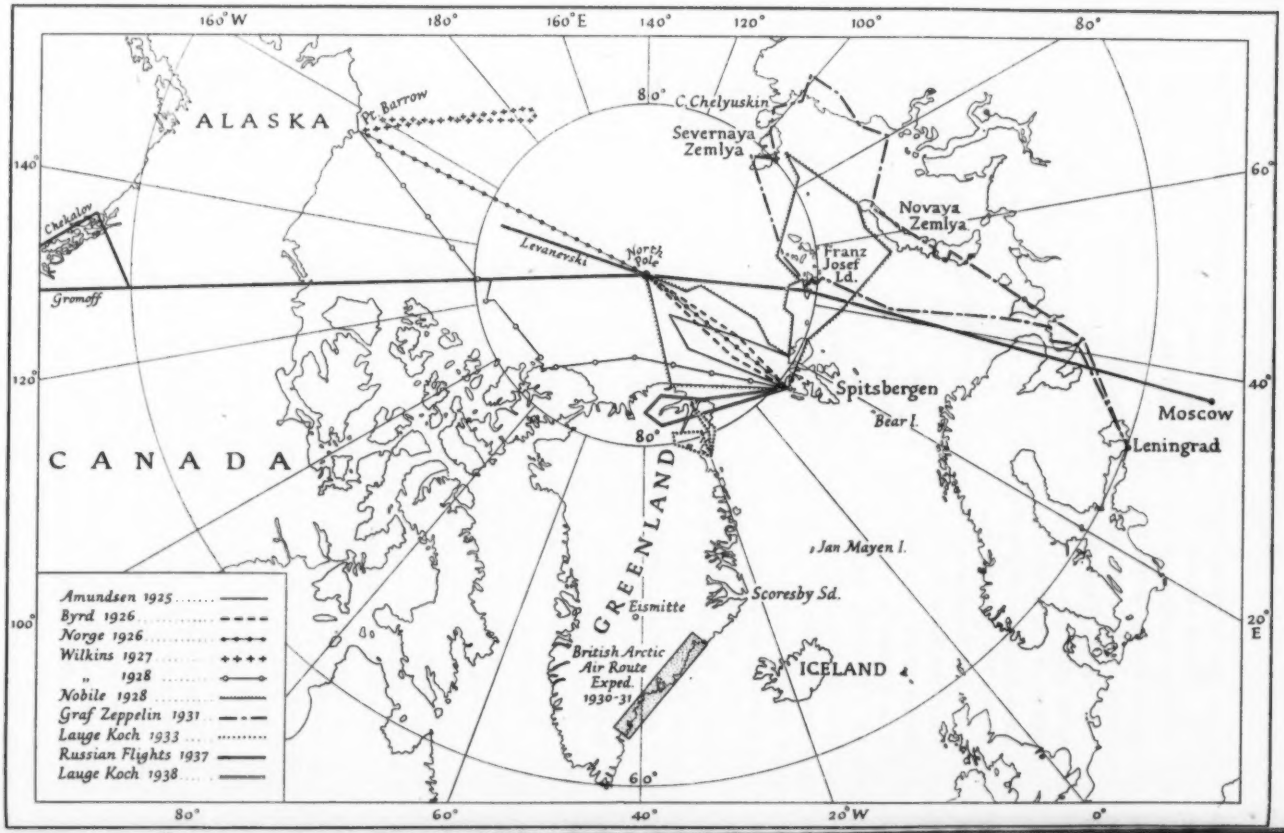


Arctic flights of Aries

In order that the greatest value might be extracted from the findings of the expedition, it was obvious that special care must be given to navigation so that the exact position of recorded phenomena might be determined. For this reason the navigators were anxious to undertake the flights when the Polar basin was in total darkness, which would have afforded a full choice of stars and planets from which to obtain fixes. Since however the first two months of 1945 were occupied in detailed planning and the aircraft was still unprepared, it was decided to chose a time when the sun and moon would give good navigational facilities throughout the day. The minimum conditions were that both the sun and moon should have northerly declinations and be some 60 degrees or more apart. Such conditions lasted only for about six days in March and April and five days in mid-May. Thereafter the period dwindled to two days or less in each month until the following September, so that if an attempt was to be made in 1945 the latest date for starting was May 15. The closing stages of the war in Europe and uncertainty as to when hostilities would end delayed the final preparations. It was not until 10 May 1945, two days after V.E. Day, that we finally left for the Icelandic base from which the first flight was to be made.

By a strange coincidence, the *Aries* left the United Kingdom on the centenary of the ill-fated expedition led by Sir John Franklin in search of the North West Passage. Although we did not propose to make an attempt to reach the Pole before May 15, we left for Iceland five days earlier so that we could get some rest after the weeks of hectic preparation, and discuss the details of meteorological forecasting with Air Headquarters, Iceland. The forecasting proved a most difficult task, as the Meteorological Staff at Reykjavík was being asked to provide an appreciation of weather conditions over some 400,000 square miles of the Arctic Basin with scanty information from no more than half a dozen reporting stations as far removed as Iceland, Jan Mayen, Spitsbergen, Siberia, the Bering Straits, and north-west Greenland. During these five days we made a series of observation flights far up the Greenland coast to examine possible landing areas and locate food caches, and at the same time to have a final run through our general flying technique in high latitudes. We still had much to learn of the practical difficulties in effecting a change in navigation technique at about 72° N., in which latitude we planned to exchange Mercator for Polar Stereographic charts, at the same time switching to the Greenwich grid system of orientation. The change had been practised earlier in a synthetic trainer, but only under actual Arctic conditions could we perfect our technique.

As all the detailed planning had been completed by the afternoon of May 13, we decided to leave Iceland at 0300 hours on May 15 in an attempt to reach the North Geographical Pole. During the early afternoon of May 14 however meteorological reports indicated that a postponement of twenty-four hours would be advisable to allow an area of bad weather in the Norwegian Sea to disperse. Advantage was taken of this enforced delay to dispatch an aircraft from Iceland up the eastern seaboard of Greenland to about 75° N. to make a reconnaissance of prevailing weather conditions. The flight was timed to return about 0100 hours May 16, so that if the weather report was favourable we could depart at 0300 hours. What we feared most was a


160° W
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ALASKA
Pt. Barrow
80°
C. Chelyuskin
Severnaya Zemlya
Novaya Zemlya
Franz Josef Ld.
Chekalov
Levanevski
North Pole
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140°
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Spitsbergen
Bear I.
Moscow
Leningrad
CANADA
GREENLAND
Jan Mayen I.
Scoresby Sd.
Eismitte
British Arctic Air Route Exped. 1930-31
ICELAND
80°
60°
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Amundsen 1925
Byrd 1926
Norge 1926
Wilkins 1927
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Nobile 1928
Graf Zeppelin 1931
Lauge Koch 1933
Russian Flights 1937
Lauge Koch 1938

obable area of medium-level cloud lying north of Iceland and giving rise ice formations. In our already overloaded condition we could not afford be burdened with ice or buffeted by turbulence, since any severe additional ad might cause strain and even structural failure. At the best it would iously reduce our speed and range. However, the meteorological recon-issance flight reported very favourable conditions to the limit of its patrol, d so we set out from Iceland at 0300 hours on May 16 on what proved to an unsuccessful attempt to reach the Pole.

We took off from Meeks Field in a half gale and climbed steadily away to e north-west, intending to round Cape Horn and proceed due north to rike the north-east coast of Greenland, and from there to run up the eridian of 10° W. to the Pole. Shortly after rounding Cape Horn we ran to cloud at about 13,000 feet, but though it was fairly persistent, we were enerally above it at 15,000 feet. In less than an hour the cloud began to crease rapidly, and at about the same time we crossed the edge of the ice-ack. Variable amounts of cloud persisted down to very low levels, but a oticeable break was observed to the eastward, and so we altered course wards Jan Mayen in an attempt to break through in the general direction f southern Spitsbergen. After trying to break through for more than four ours, and with speed dangerously reduced by the load of ice, we decided to eturn to Iceland, since the range remaining would not allow a safety margin ven if we could find a gap in the cloud wall. And so, maintaining altitude ecause of the dangerous-looking ice-crystal haze below, we made our slow eturn to Meeks Field, landing at 1200 hours after a total flight of nine hours, uring which we had not achieved any part of our object, though we had ained some useful information about weather tendencies.

A further conference with the meteorologists in Reykjavík indicated the resence of an area of bad weather north of Iceland, but with a marked esterly trend. It was suggested that a track considerably farther to the east ould clear most of the affected area, and I therefore decided to make a econd attempt as soon as we had refuelled and fed. Within two hours of anding we were again heading towards Cape Horn, whence we planned to pass to the east of Jan Mayen, cross to Peary Land, and so northwards to the Pole. A small area of ice-forming cloud was encountered shortly after cross-ing the edge of the ice-pack, but though it proved very persistent it did not cause a serious loss in manoeuvreability. Rain was encountered south of Jan Mayen when flying at about 14,000 feet, and although the temperature was about −25° C., ice previously formed on the aircraft was washed off: a point which should be of interest to meteorologists. Full power and flexibility of the aircraft were thus restored, and soon after passing Jan Mayen we shaped course for Peary Land. About 200 miles north-west of our turning-point we encountered more severe icing, but after little over an hour, and by then in a somewhat lightened state, it was possible to outmanoeuvre the dangerous cloud area of some 200 miles depth, and so break through to the Greenland coast.

The remaining run to the Pole was made at about 14,000 feet in variable amounts of cloud, but never of sufficient density fully to obscure the sky or the surface of the ice. The whole of north-east Greenland was visible and seemed to conform closely with the outlines and contours shown on our

charts, though it was not possible to see the actual coastline because of the encroaching ice-pack. The compacted nature of the snow and numerous black rock faces indicated recent high winds. Wind strength measured at our flight level at no time exceeded 15 miles per hour, but the raggedness of the cloud formations well above our level indicated very strong winds. It was before leaving Peary Land that we saw our only sign of life in the Arctic wastes. Winging its way northwards at about 12,000 feet was a large black-and-white or grey bird, which appeared to be a member of the goose family.

A striking feature between Peary Land and the Pole was the number of leads of open water in the ice, some of them several miles in length and several hundred yards wide. Photographs show that they extended right to the Pole itself, and it was noticeable that many more ran east–west than in any other direction.

Our original plan was to reach the Pole with the sun straight ahead, so that we could run straight in with little risk of navigational error. The failure of our earlier attempt however put us ten hours behind schedule, so that we had to rely on the moon for a check position-line to tell us when we crossed latitude 90° N. This meant steering slightly east of north and, when our sun-moon fixes showed us to be in the immediate vicinity of the Pole, turning to port to fly across it. The final run of almost 600 miles across the Arctic basin was one of considerable strain for the navigators, who obtained some sixty astronomical position-lines during the run. A short period of flying under a totally obscured sky gave some relief while we resorted to a master gyro for steering; but as soon as we sighted the sun and moon again the navigators returned to work. The meteorologists had indicated that we would be free of cloud at heights above 10,000 feet in this area, yet variable amounts of cloud persisted at our flight level, often reaching 10/10 coverage. Above us at some 36,000–46,000 feet there was a considerable quantity of cirro-form cloud. The sun was now falling away in a flat arc towards the horizon and the moon, in little more than quarter state, was not too easy to observe through the ice-crystal haze. This haze was very persistent all over the Arctic basin and varied in intensity, sometimes reducing visibility to between 2 and 5 miles towards the ground. Deep blue in colour and crystalline in structure when viewed against the sun's rays, it looked as if it would be dangerous to any one forced to fly through it.

Shortly before 0200 hours on May 17 we were within a few miles of the Pole when the navigator called an alteration of course to take us over the top. Quite a lot happened in the next few minutes: the wireless operator off duty began to peel a banana, which he had procured in Gibraltar ten days before, and was preparing to eat while crossing the Pole; the operator on duty was in contact with Reykjavík and was passed a bearing of 000°; and the doctor threw a bottle of beer and the Union flag overboard. Circling the Pole before the return journey, we crossed all the meridians in some eighty seconds, and a moment later we crossed the International Date Line for the second time in less than two minutes while going in the same direction.

The return journey was comparatively uneventful. All phenomena and tendencies were noted, but for the most part in confirmation of the observations made on the outward journey. All the equipment worked faultlessly

throughout. To seek better weather for the return flight, we shaped a more easterly course, and passed closer to Spitsbergen. The weather was good until the dispersing frontal system met earlier in the day was encountered for the second time in about latitude 75° N. This led to a lengthy battle with icing cloud and unpleasant flying conditions for about two hours, before we broke through into more settled weather north-east of Iceland. We reduced altitude over the glaciers of the central tableland, and touched down at Reykjavík at 0900 hours on May 17, after almost nineteen hours in the air.

Only two days now remained in which to make an attempt to reach the Magnetic Pole. After three hours' sleep we set about preparing for an early departure on May 18. A host of tasks occupied us till 0300 in the morning of May 18, when, with last-minute meteorological data being pressed upon the navigator, we took off from Reykjavík bound for the Magnetic Pole, intending to return to Dorval (Montreal).

There was a good deal of doubt about the exact position of the Pole, so that we were actually uncertain whither we were bound. Before we left England, the Astronomer Royal had told us that he had reason to believe we might find the Magnetic Pole some 200–300 miles north-north-west of its present charted position in the Boothia Peninsula. This caused some embarrassment in our planning, because not only did it add almost 600 miles to a flight of some 3500 miles, but it gave us no point at which to aim. We finally planned to fly to the charted position in Boothia Peninsula and, if our detection gear failed to indicate a null field at that point, to proceed north-north-west and note the change and signs of the field.

Climbing easily out of Meeks Field, we ran into cloud at about 7000 feet and were still in it at 15,000 feet. Ice did not form however although the temperature indicated about 67 degrees of frost. For several hundred miles we continued in cloud, only gaining occasional glimpses of the sun and moon. Radio and radar aids were plentiful and accurate, and some hours later the eastern coast of Greenland was observed on the radar screen. Shortly after crossing the coast the cloud cleared completely, leaving the ice-cap in full view all the way to Davis Strait, which we reached two hours later. Close to the coast, on this and a subsequent crossing, we observed a series of twin marks, not unlike those left by skis or sledges but wider apart. No suitable explanation has been found, although it has been suggested that they may have been the tracks of polar bears. During the crossing of the ice-cap a radio altimeter sounding was taken, which showed it to be some 8500 feet above sea-level. The general appearance was of an unbroken mass of compacted snow, slightly rippled like a sandy shore.

Just before crossing the western seaboard we experienced our only serious mechanical failure of the whole expedition. An electrical generator bearing failed and the generator had to be isolated, with the result that the full load of the electrical circuits was thrown on the one remaining generator. This might have meant either failure of the second generator in time or at the best a fall in our supply voltage, which in turn would have led to inaccuracies in our detection gear. Two alternatives were open to us; namely, to isolate some of the gear and in consequence reduce the scope of our survey, or to return to the nearest suitable airfield for repairs. We chose the latter course, though

Goose Bay in Labrador, our nearest suitable airfield, was some 1200 miles away. The flight south down the Davis Strait was very beautiful but not very profitable, since some of our detection gear was now isolated. We did however take the opportunity of measuring the magnetic variation very frequently during the flight, and it proved to be very different to that indicated on our charts. This tendency had already been noted in other areas.

It was 1700 hours on May 18 when we landed at Goose Bay, and rolled down what must be one of the finest runways in the world. After a hasty meal we returned to work: the navigators to planning their new route; the pilots and maintenance teams to servicing the aircraft. We worked long and feverishly to replace the faulty generator, with the knowledge that we now had only thirty-five hours left in which the sun and moon would afford favourable fixing facilities. We hoped to leave in the late afternoon, but a forecast of bad weather and severe icing over the early stages of our route delayed us by several hours. After a few hours' restless sleep, we made an early departure on May 19 in almost tropical heat. The temperature change within twenty minutes of take-off was phenomenal: the mercury fell more than 100° F. before we reached 15,000 feet.

On the flight to Boothia, our only real difficulty was in traversing several small areas of bad weather which produced some quite violent though small snowstorms. Ice formation was noted, but it was never very severe. Radio and radar functioned well, but the magnetic compasses were erratic and we steered steadily on by astro-compass. Variation changes became very marked as we approached Boothia and any tendency towards unstable flight made the compasses wander aimlessly. When within some 200 miles of the charted position of the Magnetic Pole, all the compasses indicated the same direction so long as the aircraft remained steady, but the smallest acceleration or deceleration caused the free magnetic compasses to swing hard over to east and remain locked until steady flying was resumed. On the final run up the Boothia Peninsula at a height of some 15,000 feet, all the magnetic compasses pointed north-north-west: our first indication that the Astronomer Royal's conjecture was at least broadly correct. The flight so far had been somewhat slower than planned because of head winds and the failure of the automatic pilot, which necessitated using manual control. Reaching the charted position of the Magnetic Pole, we turned north-north-west and, with a dip angle of only 87°, prepared to follow the tendency until a total flight time of about twenty-two hours had elapsed. Two hundred and fifty miles north-north-west of the charted position the dip had increased to 89½°, but still the magnetic compasses indicated north-north-west to north, although now exceedingly sluggish. This had to be our turning point. At this point the total horizontal force was less than 2 per cent., yet all the magnetic compasses indicated the same (and what well may prove to be the correct) direction: a worthy recommendation for a mass-produced article.

While returning direct to Montreal down the eastern shores of Hudson Bay, we experienced the only night flying of the whole expedition. Course checking and positioning by astro were very easy, and much useful magnetic data were collected. It was during this stage that we obtained some extremely deceptive radio information, which we attributed to long-range bearings and

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Aries

North coast Disko Island, and pack ice

the fact that many of the stations were in darkness whilst we, in the early part of our flight, were in daylight. Astro-positioning, as well as pin-pointing down the coast of Hudson Bay, left no doubt as to our position, yet a radio plot placed us several hundred miles away across the Davis Strait.

Roof tops poking through the fog and a green light winking from the control tower at Dorval were a welcome sight as we circled the airport. Slowly, over what we judged as the airfield boundary, we sank into the fog and ran on to the runway with a sigh of relief.

By May 21 we had thus achieved our two main objects, and had amassed a wealth of information which would take many months to sift. Two of our conclusions were immediate and outstanding: Maclure's suggestion for high-latitude orientation was a complete success, and a magnetic survey from the air was perfectly feasible. We still could not say exactly where the Magnetic Pole lay; of one thing only could we be certain, that it did not lie in Boothia Peninsula.

To make a practical application of our findings we decided to make a long non-stop flight from the extreme north-west of Canada to England, passing well north of Boothia and south of the Geographical Pole. This would afford a check test on the magnetic polar tendency and open up a new area for our survey. Fairbanks, Alaska, would have been the most suitable air base for a northerly track with good starting facilities, but there was not sufficient time to conclude the arrangements with the U.S. authorities. We therefore chose Whitehorse in the Yukon for our base, with Edmonton, Alberta, as an alternative if turbulence should develop over the Rockies.

The most difficult part of all the earlier flights had been the provision of meteorological data covering our routes, but since in each case we had returned to the same general area, forecasting had not been an insuperable problem. For our final flight however we required a forecast extending almost half-way across the world. It was finally agreed to divide the area into two sections and pool the resulting information at both our possible starting-points, where the local meteorological staff would provide a forecast. The Western Division of the Canadian Department of Transport would deal with the first stage of our flight to the west coast of Greenland, and the North Atlantic division of Transport Command with the final stage to England.

The remaining forty-eight hours before our departure took us to Ottawa, where we reported to R.A.F. and R.C.A.F. Headquarters; to Toronto for a final "met" conference; to Rivers for a short discussion with the Canadian Central Navigation School; and to Edmonton for a final aircraft and weather check, before going up the trail to Whitehorse with the promise of favourable weather for our long stage home. This was truly wonderful country and we all looked forward to seeing the mighty Rockies on our 1000-mile journey north. We met nothing but rain, hail, snow, and blizzard until we reached the Watson Lake far up in the Yukon. Thence, running in under an overcast sky, we saw the northern reaches of the Rockies in all their splendour. Coming in to land at Whitehorse, we rolled down on to the Dominion's most westerly, and certainly one of its most magnificent, airfields. A single runway standing on a plateau some 500 feet above the Lewes river, it strangely resembled a giant aircraft-carrier hove to in the cold clear light of the western sun.

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Late into the evening of May 24 we were planning and counter-planning every stage of our route for our last long flight home to England—a route which, if we proved it possible, would save half the time taken on the present civil air routes to London.

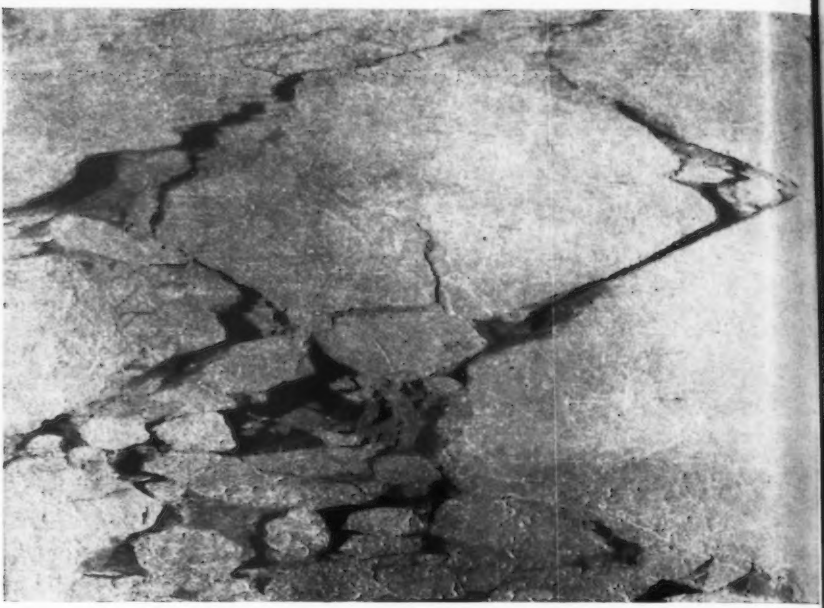
The morning of May 25 broke fair and promising, though the final weather forecast indicated a slower flight time than that on the previous evening. Leaving shortly after 1000 hours, we climbed out over the valley and moved slowly away to the north-east, up to 12,000 feet, in perfect weather. Before clearing the Rockies however we encountered several fairly severe snowstorms and some uncomfortable flying, since icing made it impossible to climb and high ground discouraged descent. In less than an hour we broke clear of the stormy area west of the Mackenzie River, and continued on our journey to England, which was otherwise without incident.

When in a position about 74° N. 110° W., it was evident that all the compasses would indicate the Pole lying to the south of our track. Subsequent indications confirmed this tendency, and at its weakest the field strength measured less than 2 per cent. with a dip exceeding 89°. Our course took us approximately 250 miles north of our turning-point on May 19, and at the same time all the compasses pointed towards the south. This was additional proof of the Astronomer Royal's opinion that the Magnetic Pole lay some 300 miles north-north-west of Boothia Peninsula.

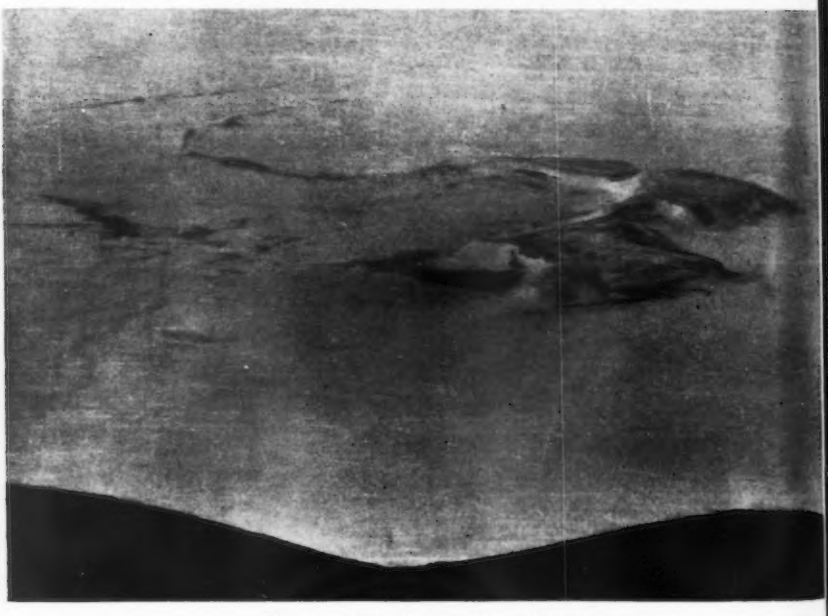
The remainder of the flight, across Axel Heiberg Land and across more than 1000 miles of Greenland ice-cap, provided further evidence that in high latitudes the distribution of the Earth's field is vastly different from that shown on present charts. The whole crossing of the ice-cap from the region of Heiberg Land to Scoresby Sound afforded us an unbroken view of the solid ice plateau. The charts we were using showed mountainous terrain in central Greenland, but it can be confirmed that no such mountains exist, at least within 150 miles of our track. Again, in the Scoresby Sound area, mountains up to 20,000 feet were marked, but the highest we could see and measure was about 13,000 feet on the northern side of the Sound. The desolation of the ice plateau gave way at Scoresby to magnificent mountain scenery with glaciers, like huge masses of icecream, reaching down into Scoresby Sound. The eastern edge of the ice-cap was crossed at about 0700 hours, and shortly afterwards we sighted the desolate northern coastline of Iceland.

Landing at Shawbury at 1245 hours on May 26 marked the completion of the first non-stop flight between the Pacific coast and north-west Europe, and brought to a close a series of flights over the Arctic totalling over 24,000 miles, of which more than half lay within the Arctic Circle. In one hundred and ten hours' flying over a period of sixteen days we had collected more than thirty thousand observations on magnetic phenomena alone, and a large volume of records on many other aspects of the flights. The task of sifting such a mass of data must necessarily take time. All that can be said with reasonable certainty at the moment is that aircraft can be used to obtain a fast and accurate magnetic survey, and that they can serve as general observation platforms for studying such inaccessible areas as those over which we flew. It should be borne in mind that all these results were obtained with standard R.A.F. equipment with only minor modifications. Detailed research, careful

West coast Greenland, looking towards Prince Island



Leads in ice off north-east Greenland



Shannon Island and edge of fast ice

planning, and access to specialized equipment would enormously increase the scope of such flights, and I sincerely hope that it will soon be possible to make a further series of flights of a similar kind.

To say that the flights were made in comfort would be far from the truth, though we had many compensations not accorded to earlier Arctic explorers. By the time we had stowed all our equipment and kit, the available space in the aircraft was less than that in the average railway compartment. In that space eleven men worked for stretches up to nineteen hours, in temperatures averaging 60° of frost—and we had to wear oxygen masks from start to finish of each flight.

The work of the *Aries* is but a small contribution to the huge field of Arctic research. I hope that the *Aries* flights will be followed by others sponsored by the R.A.F. which will further increase our knowledge of the Polar regions.

DISCUSSION

Before the paper the PRESIDENT (the Rt. Hon. The LORD RENNELL OF RODD) said: We hope during this session to continue the policy which was adopted at the beginning of the session of trying to show the Fellows and their guests something of what the Services have done during the war. We have had a lecture on Burma and another on the campaign in Eritrea and Northern Ethiopia, and we are to have this evening an account of recent reconnaissances by the Royal Air Force over the North Geographical and North Magnetic Poles. We propose to continue the evening meetings with a paper on the work of Coastal Command in high latitudes, and I hope there will be similar papers arranged in the course of 1946.

This evening we are fortunate in having Wing Commander McKinley to tell us about the air reconnaissances of the two northern Poles. I am sorry to say that Wing Commander Winfield, the medical officer on the flights, will not be able to speak to-night because he has temporarily lost his voice; but we shall hear something of what he had to say to us from Wing Commander McKinley. We are particularly happy to see with us some of the most senior representatives of the Royal Air Force, and we hope that they will also speak.

The reconnaissances in question started from the Empire Navigation School at Shawbury in May of this year, and altogether Wing Commander McKinley and his crew travelled 24,000 miles. This is the result of some of the lessons learned in long-distance navigation during the war, which they have immediately put to another purpose. It is the first of several reconnaissances of which we may expect to hear during the next few years, and it shows that what the R.A.F. have learned in the course of the war can be put to the world's use in times of peace. I call on Wing Commander McKinley.

Wing Commander McKinley then read the paper printed above, and a discussion followed.

The PRESIDENT: We have in the hall this evening a number of people who, I am sure, will wish to speak. I will first call upon Commander Glen, who has had recent experience of high-latitude flying. We have with us also Mr. Augustine Courtauld, who has personal experience of the ice-cap, and we shall hope also to hear some of the senior officers of the Royal Air Force.

Commander A. R. GLEN: I should first like to congratulate Wing Commander McKinley on a remarkable series of flights. I was particularly struck by his

description of the "short" diversion of 1000 miles, which, I think, conveys to all of us something of the magnitude of the task which confronted him. It was indeed a splendid exploit and I congratulate him and his air crew most sincerely.

I think we should consider the *Aries* flights against the background of high-latitude flying which the R.A.F. have carried out throughout the war—a programme perhaps not known to most of you—when the aircraft of Coastal Command covered the sea route between Iceland, North Greenland, Spitsbergen, Nova Zemblya, and North Russia month in and month out through those dreary years of 1942 and 1943. Flights of up to thirty-six hours in duration were carried out regularly in the face of intense enemy opposition as routine operations of war. It was a noble record and one fitly crowned by the *Aries* flights, which finally took an aircraft of the R.A.F. to the North Magnetic and North Geographical Poles.

In these flights there is something of real importance to geographical exploration after the war. Consider for a moment that in the years before the war these far northern and southern regions were visited mostly by a few sealing vessels with a maximum speed of 5 or 6 knots and a deadweight often of less than 100 tons, while to-day the modern aircraft can carry, in a few hours over a range of 2000–3000 miles, pay-loads of 8 or 10 tons. The technique of parachuting men and supplies has been perfected, and it is now possible for a station to be established on the Greenland ice-cap and research maintained for a year with half the effective pay-load of a modern aircraft. Exploits of the last five years have opened up possibilities which can revolutionize research in the polar regions.

One of the really happy memories of the war is the close association which has existed between the R.A.F. and this Society, and I feel to-night that the association may be carried into the future. The R.A.F. have played a fine part in polar exploration in the last five years—a part which was made necessary by the grim demands of war, but which can produce equal results in the years of peace which we hope lie before us. I would like to end by expressing the earnest hope that the cooperation which has existed during the war may be continued and become still closer in the years to come.

The PRESIDENT: We have here Squadron Leader Hagger, who was a member of the crew on this flight. Perhaps he will say a word.

Squadron Leader HAGGER: I am at a loss to know what I can say which will interest you, but perhaps I may add something to what has been said about the navigational procedure which we adopted on the polar flight, and which we hope may become standard for future polar flying. Wing Commander McKinley has already mentioned the Greenwich grid system of orientation devised by Wing Commander Maclure, and I am confident that the method we used will prove to be the best one and will be followed in future flights. It proved to be entirely successful; but you may appreciate the feelings of a pilot who, proceeding from Iceland, as we were, by conventional methods, was suddenly told by his navigator that he was going over to the Greenwich grid, and saw his distant reading compass veer round from 010 degrees to a course of 190 degrees while the aircraft was still going in the same direction. It was the fact that we knew we had to continue in the same direction which kept us going at that moment.

The PRESIDENT: I should like to call on Mr. Wordie, one of the Hon. Secretaries of this Society, who will I am sure have something to say to us from his own experience of navigation in the Arctic.

Mr. J. M. WORDIE: Mr. President, first of all I wish to offer my congratulations to the lecturer and his crew on their wonderful flights, and for doing in a few days what could not have been done in the past in anything short of years. The lecturer asked for questions, and I would like to ask him how it is that the

Magnetic Pole has moved so far north. I have always understood that, apart from the Geographical Pole, there are also a Magnetic Pole and a Geomagnetic Pole. The last-named, I believe, represents where the Magnetic Pole would be if there were no disturbances from the Earth's surface crust. The Geomagnetic Pole was the only one which mattered when cosmic ray experiments were made in north-west Greenland in 1937. It would be interesting to know if the position of the Magnetic Pole affects the Geomagnetic Pole also, or if the latter is more stable than its erratic brother.

Mr. JOHN GRIERSON: I also should like to congratulate Wing Commander McKinley and his crew. I was most impressed by hearing him speak of his various navigational methods, but I was amazed to hear no mention of the ordinary map. In the days when I flew across Greenland the map was one of my chief worries. Did he have to rely on the map at all, and, if so, did he get a map which was any good?

Mr. A. COURTAULD: The maps in those days were made by many hands and were very bad. I should think the pilot had then to rely entirely on his astronomical knowledge and navigational skill, since only the coastline was at all adequately mapped. It was not until a photogrammetric survey was completed by the Danish Geodetic Institute that the map was good enough inland for flying purposes.

Wing Commander D. C. MCKINLEY: I am afraid that in fact we did not rely very much on maps in the higher latitudes. For the most part we stuck to what our astronomical fixes told us in terms of latitude and longitude, accepting the fact that many parts of our tracks were incompletely mapped, until we arrived at some point we could recognize and pin-point. I think it is true to say that the mapping is not very accurate in detail, but that the broad outlines conform fairly well.

The PRESIDENT: Would Air Chief Marshal Sir John Slessor lead us to hope that personnel will be available for these reconnaissances?

Air Chief Marshal Sir JOHN SLESSOR: I do not think there is any doubt of the usefulness of these reconnaissances, and I am sure Sir Arthur Tedder will agree with me that we shall always be able to make the necessary crews available.

Marshal of the Royal Air Force Sir ARTHUR TEDDER: Mr. President, I am not an explorer and I am not a pioneer, but I can claim to be a first-class tourist. During the last six months I have travelled from Malta to Capetown, and from London to Ottawa and Los Angeles, and both as a tourist and in my official position I take an intense interest in our ability to go from A to B when we want to. Incidentally I have not been in a ship and only once in a train for the last five years, so naturally I speak of aircraft. I have seen two forms of air travel. One is what I would call suburban travel, which has been highly developed in America, where you can go from point to point in any sort of weather under very close control from the ground with all the radio aids and so forth. (Incidentally I feel that the sooner we have this in other parts of the world the better.) But that does not apply to spanning wide distances, across the Atlantic and across Africa for example. That is the other form of travel as far as the navigator is concerned.

I am a little shaken by the awful discovery that the Astronomer Royal does not know where the Magnetic North Pole is. That is one unknown. The other, of course, is the weather. That again is where this sort of operation is handicapped. There is a great deal of pioneering to be done in the air before we know the answers to many conundrums, but all the information we can get on the weather and its vagaries by means of these pioneer flights is going to help civilization. I am sure there is a lot of good to come out of the war, and this is

one of the first items on the credit side. So far as I am concerned the R.A.F. will do all it can to contribute towards peace and civilized existence.

The PRESIDENT: We have heard a remarkable story of a flight which brought with it none of the adventures which some of the crew had hoped for. The best conducted enterprises are those in which the least happens, but the least happens because they are well conducted, and we have had an example of that to-night. Out of the discussion has come the assurance that the R.A.F. will continue to help and to conduct enterprises which are very near to the heart of this Society; to which I add the assurance that whatever the Society can do to make known these results will be done: it is the least of the contributions that we can make. Sir Arthur Tedder has taken the words out of my mouth by expressing surprise at the fallibility of the Astronomer Royal. I am very sorry he is not here to-night to answer the doubts which must arise in our minds on learning that he does not know the exact whereabouts of the North Magnetic Pole.

I feel that the paper we have had to-night, as Sir Arthur Tedder has said, shows how much is still left to be done, and we have Sir Arthur's promise for himself and his colleagues that they will contribute the experience which the R.A.F. has gained during the war towards the peace we look forward to, the development we must have, and the civilization for which we have fought.

I will ask you to thank Wing Commander McKinley and his crew and all who have made this reconnaissance possible, and to wish them luck in their future enterprises of the same sort. We hope that they and their colleagues will come and tell us about their further adventures, and how they have contributed to the science which this Society was founded to serve.

TECHNICAL ASPECTS OF THE *ARIES* FLIGHTS

Wing Commander K. C. MACLURE, A.F.C., R.C.A.F.

Afternoon Meeting of the Society, 18 February 1946

SOME, PROBABLY MOST of you, were present at the meeting in December, when Wing Commander McKinley read his paper on the Arctic Flights of *Aries*. It was not possible for him to deal more than very briefly with many of the technical aspects of the flights, and it is on these that I have been asked to enlarge. To cover all the technical aspects would take a long time, and so instead I propose to discuss a few of the more interesting and perhaps more unusual details. These can be grouped conveniently under five headings: navigation, meteorology, compasses and magnetism, radio, and topography.

Navigation

Before deciding on the navigation methods we would employ, a thorough survey was made of the records of all previous Arctic flights. It is perhaps not generally realized how many successful Arctic flights were made in the twenty years or so before the late war. From the logs of these flights we obtained some useful information such as, for instance, the compasses used by Sir Hubert Wilkins in 1928, and the weather encountered by Tchukaloff in June 1937. Though designs in aircraft and navigation instruments have changed considerably since then, many of the problems of Arctic flying remain unchanged.

As was expected, the biggest navigational problem was that of measuring direction. There were several contributory reasons for this, an obvious one being the convergence of the meridians towards the Pole. It was, of course, necessary to use a polar projection instead of the usual equatorial Mercator, and of several possible projections the polar stereographic was chosen because it is conformal and the meridians are straight lines. On this projection the rhumb-line appears as a complicated curve and is therefore discarded as useless, but straight lines may still be used for plotting, as on the Mercator, and in this case approximate closely to great circles. It is awkward however to measure the direction of such lines from the local meridian, because, instead of being constant, the direction changes continually along their length. We solved this problem by using the Greenwich grid system of orientation, suggested by myself in 1941 especially for polar air navigation, and later approved by the British Commonwealth and United States Air Forces. I have since learnt that a similar method was proposed in 1928 by the Italian hydrographer, Captain L. Tonta,[1] but was never widely used.

The principle of the Greenwich grid system is that local meridians are ignored, and instead all directions are measured in relation to the meridian of Greenwich. The direction of Greenwich from the Pole is taken as 000°

[1] L. Tonta, "Submarine phonotelemetry," *Hydrographic Review*, Vol. 5, No. 1 (1928), pp. 91–125.

"Greenwich," or 000° "G," and, whatever an aircraft's latitude and longitude, if its course when plotted is parallel to the meridian of Greenwich, it is said to be flying 000° G. If it alters course 90° to starboard, the new course is 090° G, and so forth, the normal clockwise rotation from 0° to 360° being retained. One advantage of this convention is that at the Pole the direction of any heavenly body in degrees "G" is numerically equal to its Greenwich hour

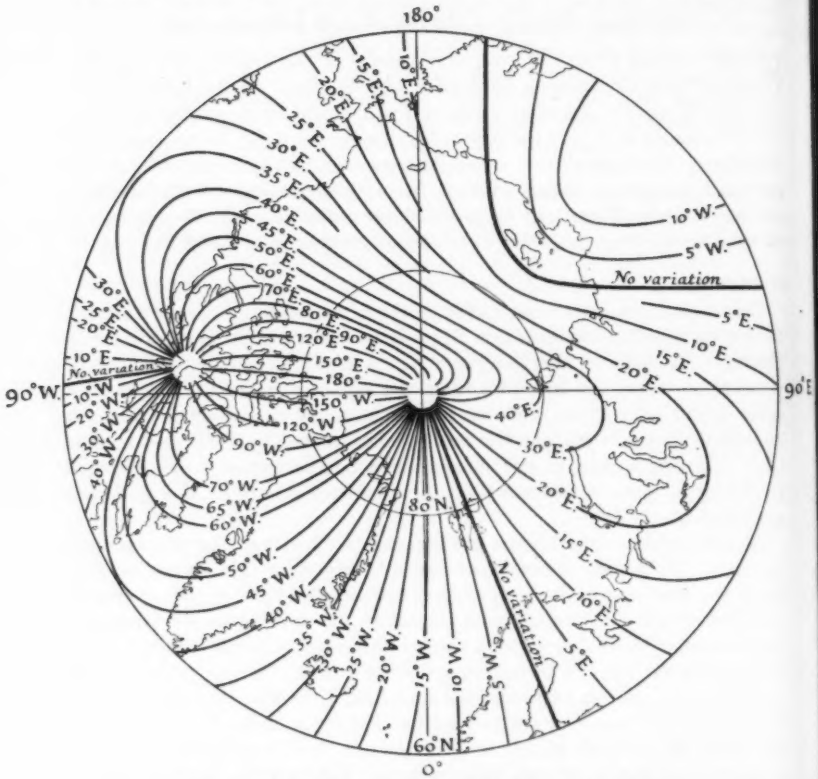


Fig. 1. Isogonals of magnetic variation in the Arctic

angle. Even 10° or 15° from the Pole this is approximately true, which considerably simplifies the problem of orientation. Again, due to the properties of the stereographic projection, a simple formula connects the "true" system with the Greenwich system: direction in degrees "G"=direction in degrees "T"+long. W. (or−long. E.)±180°. It should be noted however that the latitude and longitude graticule is retained for expressing position, because of its use in astronomical calculations. On all three of the flights the Greenwich system worked perfectly, and we used it whenever the polar projection was needed for navigation plotting: that was, generally speaking, for all latitudes

north of 70° N. So long as frequent observations of the sun were possible, we were never in doubt of the aircraft's course, even when its exact longitude was uncertain.

A second navigational problem is associated with the use of the magnetic compass. In the first place, as may be seen in Fig. 1, the isogonals of magnetic variation terminate at both Geographical and Magnetic Poles, with a resultant

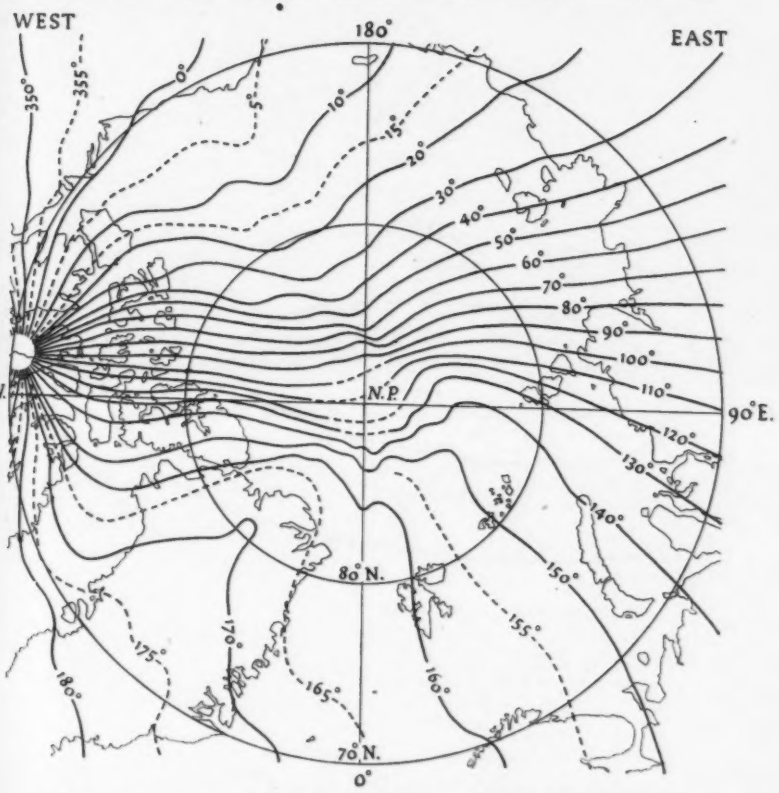


Fig. 2. Isogonals of magnetic variation on Greenwich grid system

congestion of lines on the chart. This picture can be simplified by expressing the variation in degrees "G" instead of "true" (which is logical if navigational measurements and calculations are to be made in degrees "G"), and plotting the new isogonals. Fig. 2 illustrates how these new "grid variation" isogonals spread out much more evenly, the Geographical Pole no longer being a point of singularity.

A more serious problem however is the weak directive force of the magnetic compass when near the Magnetic Pole, and the comparative inaccuracy of existing magnetic surveys over a large part of the area. This can best be

illustrated in a chart. In Fig. 3, the horizontal component of the earth's field within area A is 0·04 gauss or less (that is, less than one-quarter its value in this country), while within area B it is 0·08 gauss or less. Broadly speaking then, within area A the magnetic compass is almost useless, while within area B its indication should be treated with reserve, and checked when possible by astro or other means. The solution we adopted was to check the

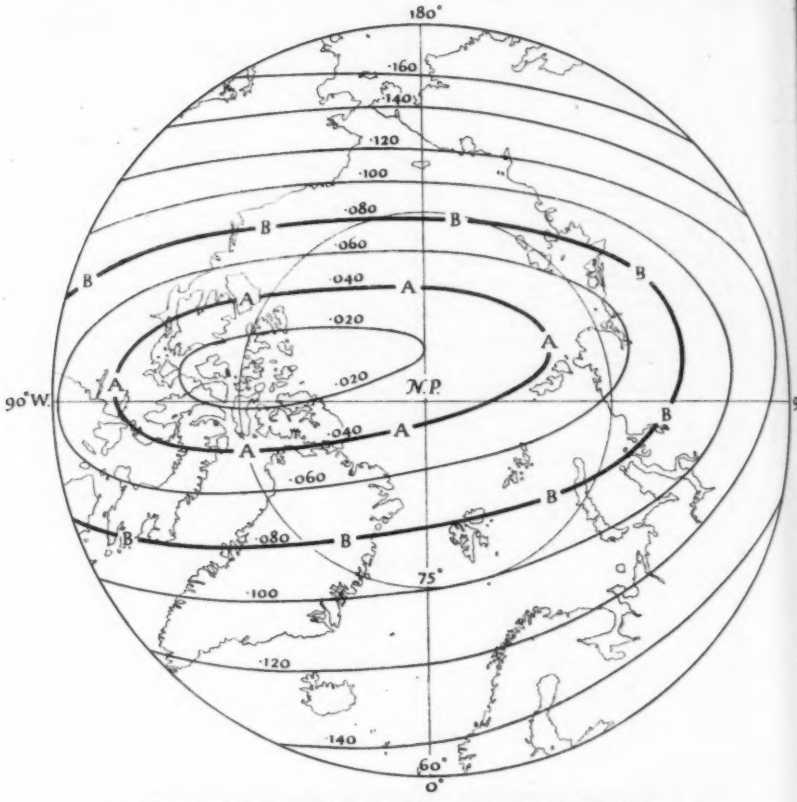
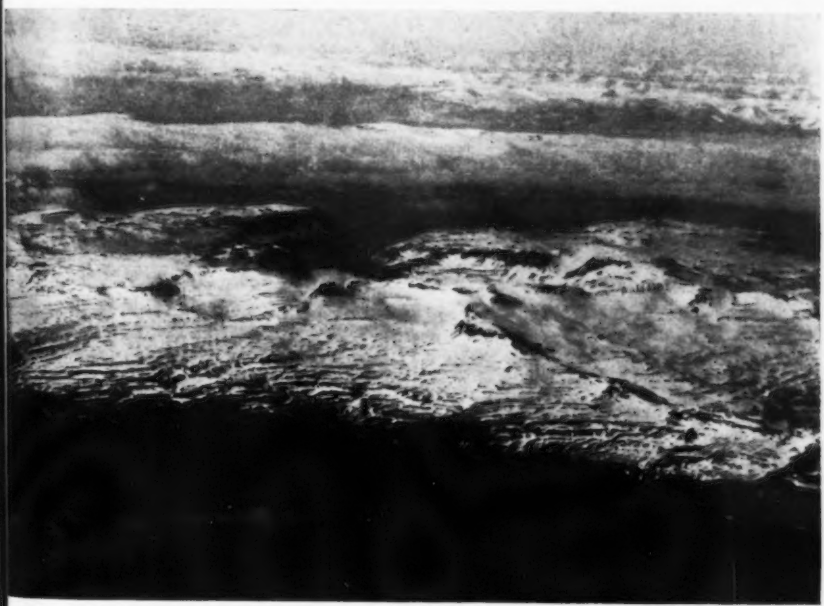


Fig. 3. Approximate curves of equal horizontal force in gauss

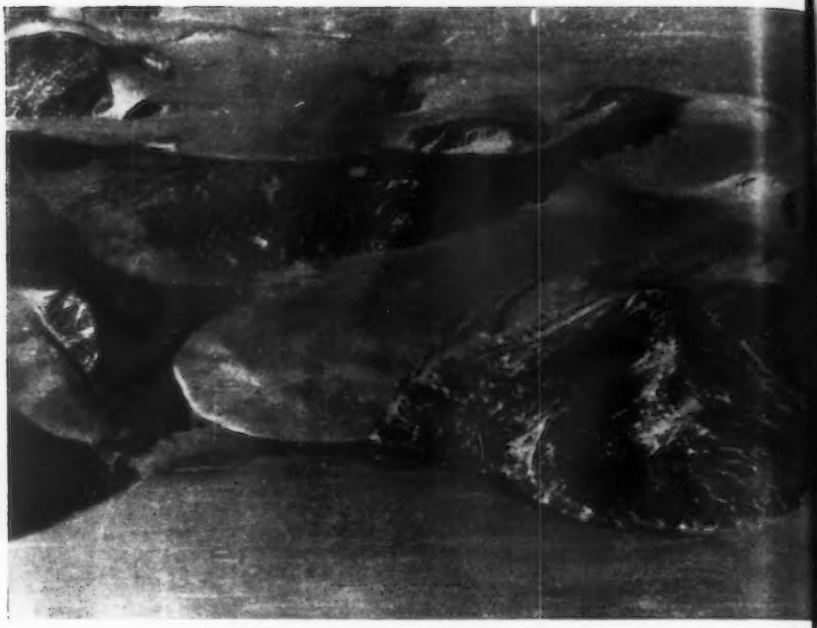
course by astro-compass observations of the sun at intervals of quarter or half an hour, relying, when the sky was obscured, on a specially constructed, large-size, directional gyroscope.

A third navigation problem of interest concerns the astro-observations. As we were out of range of radar-fixing aids and for the most part above cloud, not only direction but also position had to be determined from astronomical readings. It was May when the flights were made, and the Arctic day was twenty-four hours long. If astronomical fixes were to be obtained, the flights

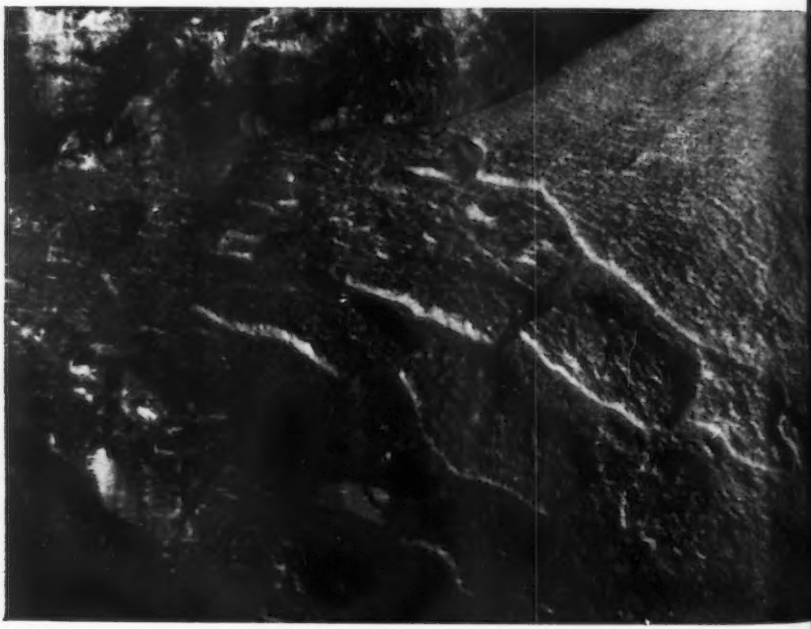
Approaching Scoresby Sound from the north-west



Cape Dalton, east Greenland



Glaciers entering Hall Fjord, Scoresby Sound



Glacier calving, Hall Fjord, Scoresby Sound

had to be made at a time when the sun and moon were approximately 60°–90° apart and the moon had a northerly declination. Such conditions existed for only five days in mid-May, and thenceforth for lessening periods, which was one of the main factors determining the date of the expedition.

Astro-navigation tables (A.P. 1618) were available to 80° N., but from there to the Pole the polar intercept method was used: that is, the Pole was taken as an assumed position, the intercept being simply the difference between declination and observed altitude. To assist in plotting the rather long position lines which resulted, a special template had been constructed with the help of the Nautical Almanac Office.

The navigation instruments we carried with us were as follows: an R.A.F. type of distant-reading compass (a gyro-stabilized master unit in the tail of the aircraft, with repeaters for the navigator, pilot, and research officer); a non-stabilized direction-reading magnetic compass for pilot's standby; an astro-compass; a special directional gyroscope; and the usual set of navigation instruments to be found at the plotting table of an R.A.F. heavy aircraft. In addition, sextant observations were taken from the rear dome, and occasionally by the second pilot from the front dome. The gyro-stabilized distant-reading compass was used as a direction indicator almost continually throughout the flights. It proved quite reliable, even in regions where the horizontal component of the earth's magnetic field was as low as 0·03 gauss, provided that it was checked at frequent intervals by astro-compass observations on the sun.

The magnetic compass linkage, and the methods of taking observations, can best be illustrated by means of a schematic diagram (Fig. 9). The solid lines indicate electrical transmission lines, and the dotted lines indicate visual checks. The astro-compass is placed at the top of the diagram, because upon it all the rest depended. Although the distant-reading compass master unit fed the magnetic course to the variation-setting corrector, the latter was not set to the value of the magnetic variation on the chart, but was simply turned until the navigator's repeater agreed with the "true" course (or "Greenwich" course) as determined by an astro-compass observation of the sun. The corrected setting was then entered in the navigation log. This procedure kept the various distant-reading compass repeaters synchronized with the astro-compass readings, and enabled the pilot to steer by his repeater, even when the master unit was not picking up the magnetic meridian but was functioning as a simple directional gyro. The special directional gyroscope was checked against the same astro-compass readings, and since it had a low and very constant precession rate it was used to check the navigator's compass repeater when clouds obscured the sun.

During the flight to the North Geographical Pole, the transfer from true course to Greenwich course was made immediately after crossing 70° N., the new course being set on the compass repeaters by turning the variation-setting corrector. The flight had been planned so that the sun would be straight ahead as we bore down on the Pole, and sextant acceleration errors would be reduced to a minimum. It was at this stage that we had the novel experience of flying due north at midnight, with the sun straight ahead and rising in the sky.

The technique outlined above, for plotting astro-position lines and checking the compass repeaters from sun observations, proved satisfactory enough, and we experienced no major difficulty. It was concluded later however that for latitudes 80° N. to 88° N. or even higher, astro-navigation tables would have been handier to use than the polar intercept method.

Meteorology

During the planning stage of the expedition, a careful study was made of all the available data on Arctic climatology. We had reason to believe that, except

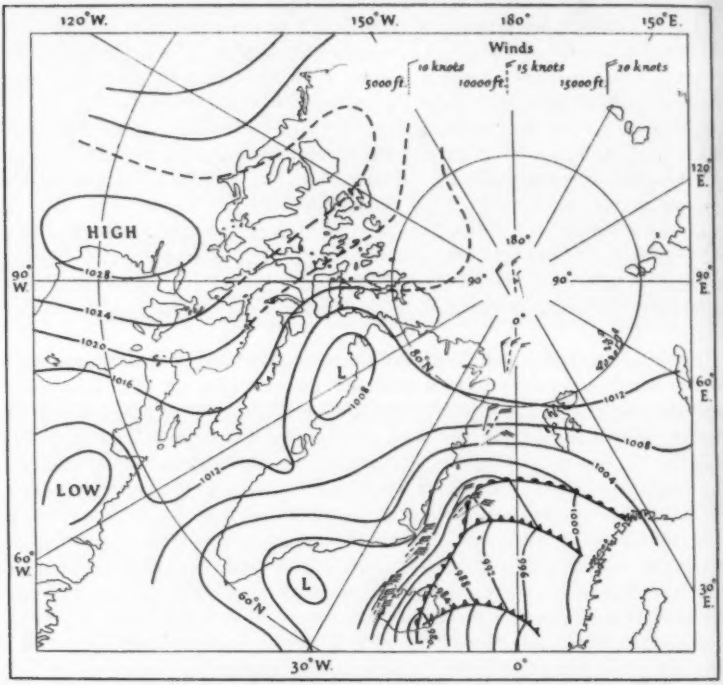


Fig. 4. Forecast weather chart, May 16/17

during the summer months, there was not a great deal of cloud over the Polar Sea, and that the winds were generally light. This was deduced from the fact that the tropopause is at a comparatively low altitude in these high latitudes, and that there is no source of bad cyclonic weather in the Arctic, though cyclones may drift into the area from the Atlantic or Pacific. Again, we were assured that any icing we might encounter would be no worse than on the North Atlantic air route, and probably less severe.

Although these conjectures were based on scanty data, particularly for altitudes of over 10,000 feet, we did not expect to run into any very bad weather which had not been anticipated by the meteorologists at our operating

base. The difficulty of forecasting was due to the insufficient number of weather reporting stations within the Arctic. Nevertheless, with reports from Spitsbergen, Greenland, Canada, and Alaska, the R.A.F. meteorological staff at Reykjavík succeeded in giving us a full forecast for the flight to the North Geographical Pole, which we found to be remarkably close to fact. The forecast chart is shown in Fig. 4. Attention should be given to the occluded front which had to be circumnavigated, the steady head winds all the way to the Pole, and the conjecture that an area of high pressure existed near the Pole.

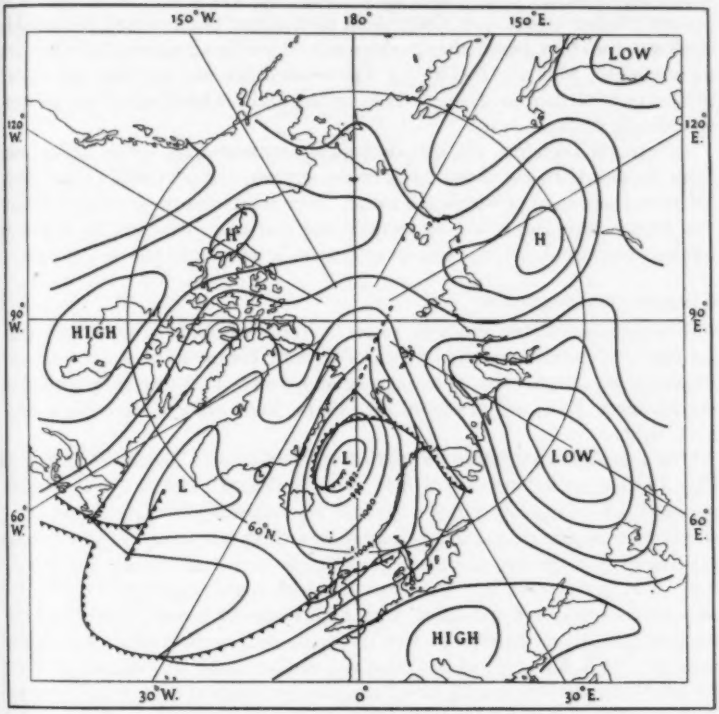


Fig. 5. Observed weather chart, May 16/17

From meteorological observations made during the flight, which included pressure, temperature, wind, and cloud, the chart in Fig. 5 was drawn to show the actual weather situation for midnight, May 16/17. On the whole it conforms remarkably closely to the forecast chart, but it will be noticed that the isobars have been pulled northwards, and that another front, presumed to be an old dying one, has been introduced close to the Pole.

The flight to the Magnetic Pole from Goose Bay to Dorval (Montreal) was relatively simple to forecast, since weather observations for the surrounding areas were readily available. The final flight from Whitehorse to Shawbury

however presented an altogether different problem—the transmission of weather observations for the United Kingdom and the North Atlantic, as well as for the whole Arctic basin, to our starting point at Whitehorse, Yukon. This was successfully arranged, mainly through the cooperation of the Meteorological Service of the Canadian Department of Transport. The Whitehorse meteorological staff was able to forecast as far east as Greenland, and the forecast for the remainder of our route was relayed from Dorval. The forecast chart (Fig. 6) showed an area of low pressure west of Greenland, which again meant head winds all the way, but cloud tops were shown as generally below 10,000 feet. Once again the forecast chart proved remarkably similar to the chart drawn after our return to show the actual weather situation for midnight, May 25/26 (Fig. 7). The main difference was that the "low" proved to be farther north than was expected, and the head winds were correspondingly stronger.

In general therefore the meteorological forecasts were quite satisfactory from the point of view of the safety of the aircraft, and provided a reasonably accurate assessment of winds and cloud. With more reporting stations within the Arctic, forecasting will be simpler and still more dependable, and it is obvious that regular Arctic transport cannot develop until this is the case.

Compasses and magnetism

The purposes of the magnetic research were threefold: to record the performance of several standard types of aircraft compass; to investigate the feasibility of carrying out an aerial magnetic survey in the neighbourhood of the Magnetic Pole; and to extend the existing knowledge of the earth's magnetic field.

The magnetic compasses we carried with us (shown diagrammatically in Fig. 8) were as follows: (1) R.A.F. type of distant-reading gyro-magnetic compass (1A—variation-setting corrector, 1B—repeaters); (2) American gyro-stabilized flux-gate compass (2A—variation-setting corrector, 2B—repeaters); (3) American magnesyn compass (3A—remote indicator); (4) special R.A.F. type of P.10 compass, non-stabilized but with high magnetic moment; (5) 01151A compass, non-stabilized, with high magnetic moment, and medium damped; (6) American type B16 compass, with vertical card, and lightly damped; (7) R.A.F. type of N1 compass, similar to the American type B16; (8) astro-compass; (9) special directional free gyroscope; (10) special dipmeter (10A—remote indicator); (11) American three-axis flux-valve magnetometer (11A remote indicator). The dipmeter was specially constructed by the Royal Aircraft Establishment at Farnborough from parts of a flux-gate compass to read dip directly in degrees. The magnetometer was a simple portable type of compass, designed for comparative rather than absolute measurements, but the best which could be installed at the time.

The method of taking magnetic observations will be seen by referring to Fig. 9. Every half-hour, and sometimes every quarter-hour, two or three readings on the sun were taken with the astro-compass. The navigator then corrected the distant-reading compass repeaters as necessary. Simultaneously, the special gyro was read and the three repeater compasses (direction-reading compass, flux-gate compass, and magnesyn) were photographed. Then, with

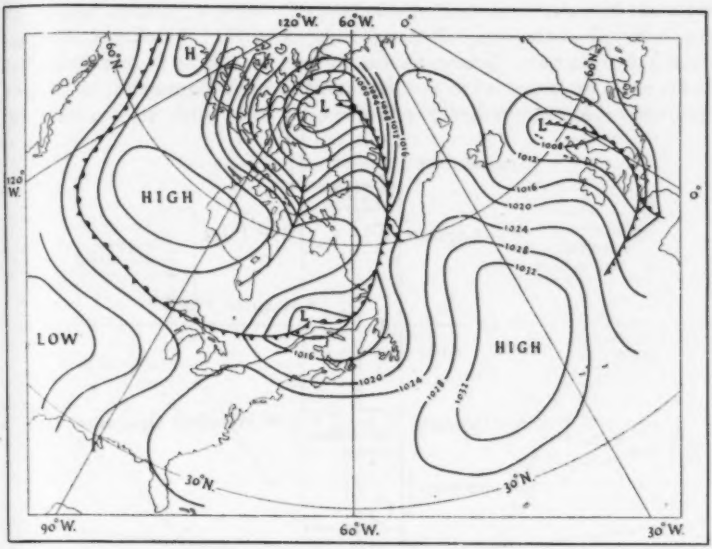


Fig. 6. Forecast weather chart, May 25/26

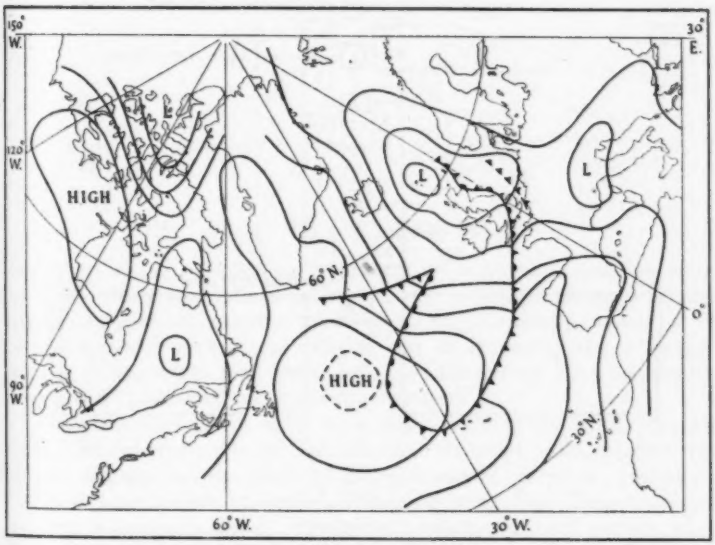


Fig. 7. Observed weather chart, May 25/26

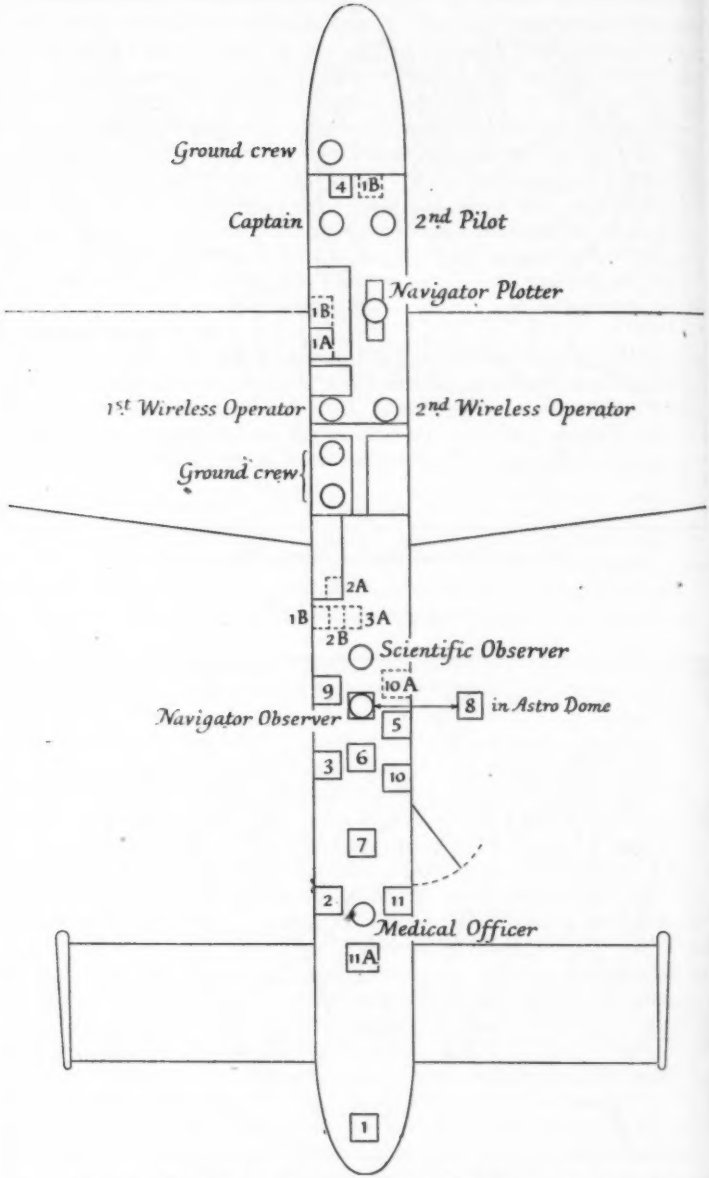


Fig. 8. Air crew stations and siting of compasses in aircraft

the camera running, a series of visual observations were taken of the other magnetic gear (01151A, B16, N1, and special B10 compasses, dipmeter, and magnetometer). The R.A.F. type of distant-reading compass had a triple role: as an instrument whose performance was to be tested; as a control on the other gear by virtue of its gyro-stabilization and photographic recording;

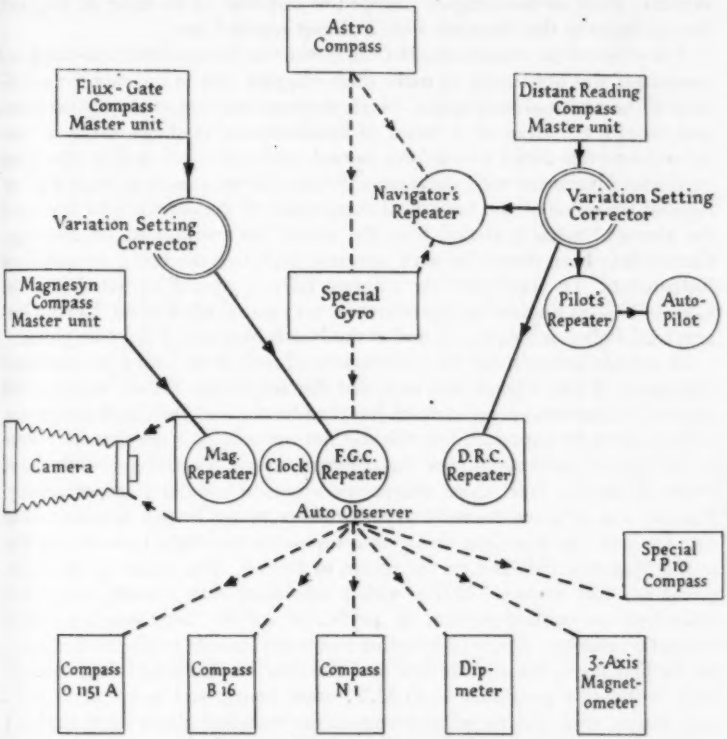


Fig. 9. Magnetic compass linkage

and, above all, as a navigation instrument in almost continuous use by the navigator, whose observations had priority. Every time the navigator adjusted the variation-setting corrector, which he did very frequently, it offset all the repeaters, which necessitated extreme care in correcting the subsequent records. It was not an ideal system for a magnetic survey, but it was the best which could be devised under the circumstances.

There was some doubt as to the actual position of the North Magnetic Pole. The Astronomer Royal had calculated its mean position (apart from diurnal changes and the effects of magnetic storms) at 76° N., 102° W., in Bathurst Island, some 300 miles north-north-west of its hitherto accepted position in Boothia peninsula. Though such a shift, or error of position, would have no bearing on navigation in areas at other latitudes which have been

accurately charted magnetically, it would be of immense significance to Arctic flying.

The data recorded for the compasses were obtained for the most part on the three main flights, large sections of which lay across areas of very low horizontal magnetic intensity. On the flight to the North Geographical Pole, the directive force of the compass dropped to one-fifth of its value in England. On the flight to the Magnetic Pole it almost reached zero.

The effect of the weak horizontal component on the aircraft's non-stabilized compasses was not simply to make them sluggish, but to increase the amplitude of their normal oscillations. Single readings were consequently valueless, and instead the mean of a series of instantaneous readings, taken at ten-second intervals over a two-minute period, was used. The way in which the oscillations increased with decreasing directive force, can be seen in Fig. 10. Against the value of the horizontal component of the earth's field is plotted the average "mean deviation from the mean" for two-minute observations. Curves have been drawn for each compass, including the two gyro-stabilized instruments. To appreciate the diagram fully, it should be noted that the value of "H" in England is approximately 0·17 gauss, while at the North Geographical Pole it is 0·04 gauss, and at the North Magnetic Pole, 0·00 gauss.

Of especial interest was the performance of each of the two gyro-stabilized compasses. From Fig. 10 it is seen that the amplitude of their short-period random oscillations averaged much less than for the non-stabilized compasses, which was to be expected, but this did not necessarily mean that they were giving correct indications. On the contrary, as the aircraft approached the North Magnetic Pole, these compasses began to wander most erratically. Figs. 11 and 12 show the relative performance of the British distant-reading compass and the American flux-gate compass on the flight from Goose Bay to the Magnetic Pole and on the return to Dorval. The x-axis in these diagrams is a time-scale (G.M.T.), with a subsidiary scale reading in nautical miles from our turning-point at 73° 40′ N., 98° 40′ W.; the y-axis is a scale of magnetic variation. Several interesting points are brought out in the diagrams. In the first place, the aircraft flew over the charted position of the Magnetic Pole in Boothia peninsula at G.M.T. 0000 hours, and again at G.M.T. 0150 hours, while the variation shown on our standard charts (indicated as a solid line in the diagram) changed through almost 180°. Secondly, the aircraft did not reach 76° N., 102° W., the calculated position of the Magnetic Pole, but the variation indicated on the Astronomer Royal's special charts (the dotted line in the diagram) was, with little deviation, followed by the compasses. Thirdly, both compasses wandered erratically between G.M.T. 2200 hours and G.M.T. 0400 hours, when the value of "H" was 0·04 gauss or less. And lastly, when a 360° turn was made at G.M.T. 2346 hours and at G.M.T. 0036 hours, the flux-gate compass picked up an error of at least 30°, but the distant-reading compass was not affected owing to its different method of stabilization.

The obvious conclusion to be drawn from this evidence is that, within areas where the value of "H" is less than 0·04 gauss (area A in Fig. 3), neither type of gyro-stabilized compass can be trusted. On the other hand, provided it is well sited in the aircraft, a non-stabilized magnetic compass can still be

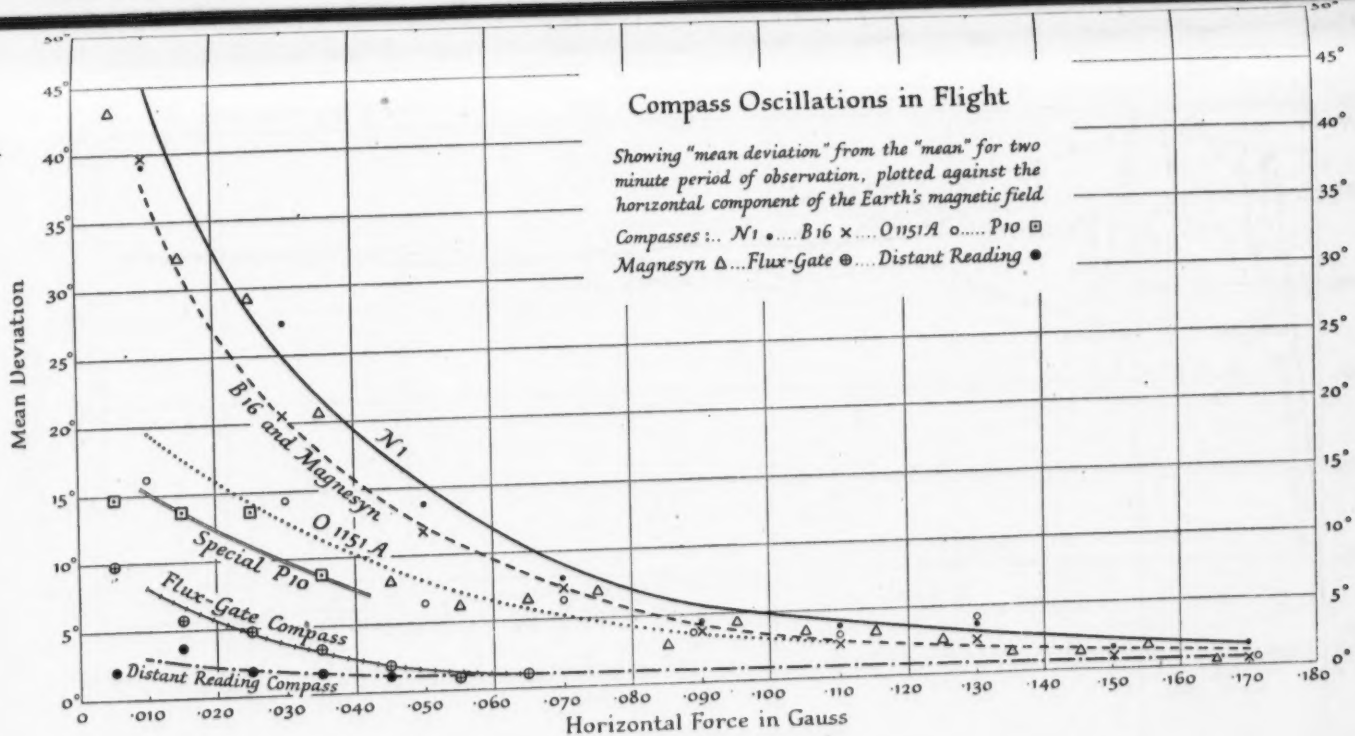

Compass Oscillations in Flight
Showing "mean deviation" from the "mean" for two minute period of observation, plotted against the horizontal component of the Earth's magnetic field
Compasses :.. N1 •....B16 ×....O1151A ○.....P10 ⊡
Magnesyn △...Flux-Gate ⊕....Distant Reading ●
Mean Deviation
Horizontal Force in Gauss
N1
B16 and Magnesyn
O 1151 A
Special P10
Flux-Gate Compass
Distant Reading Compass
0°
5°
10°
15°
20°
25°
30°
35°
40°
45°
0
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Figure 10

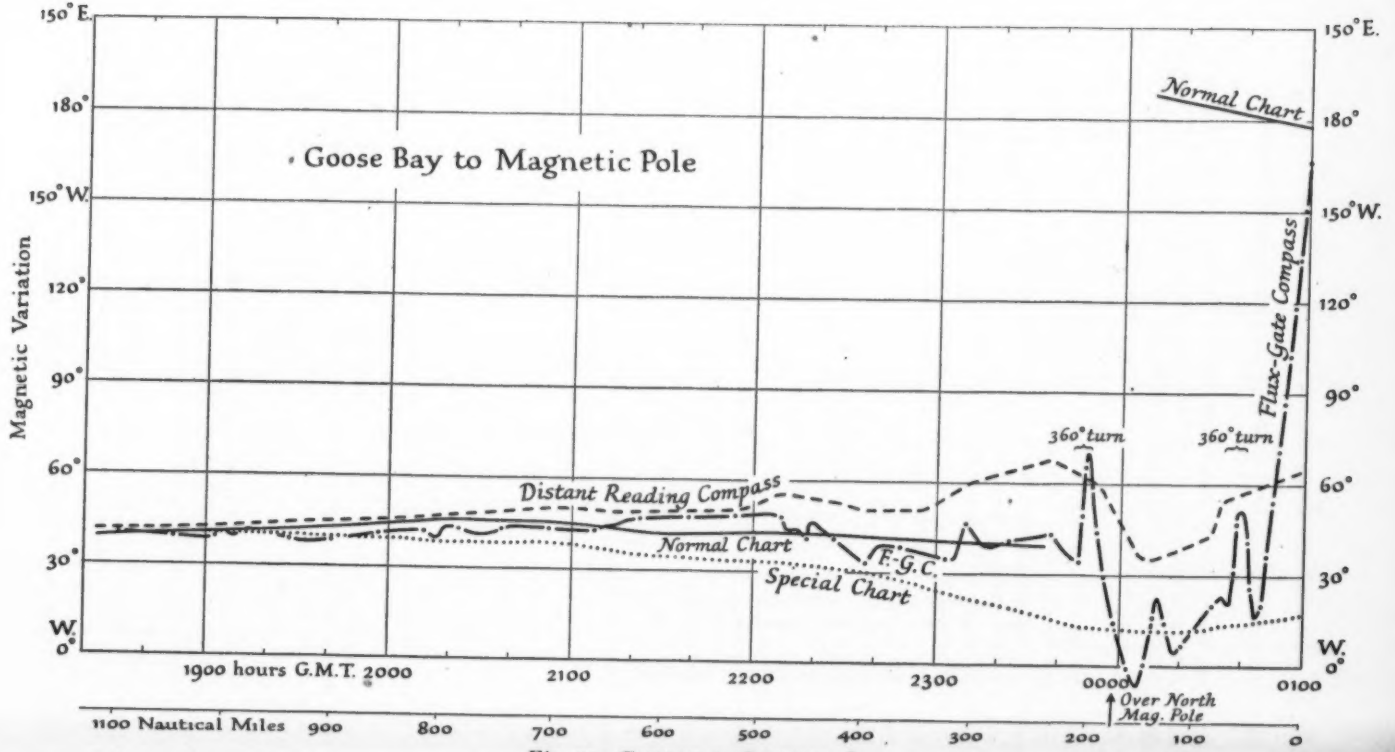


Fig. 11. Compass performance, 1

Fig. 11. Compass performance, I

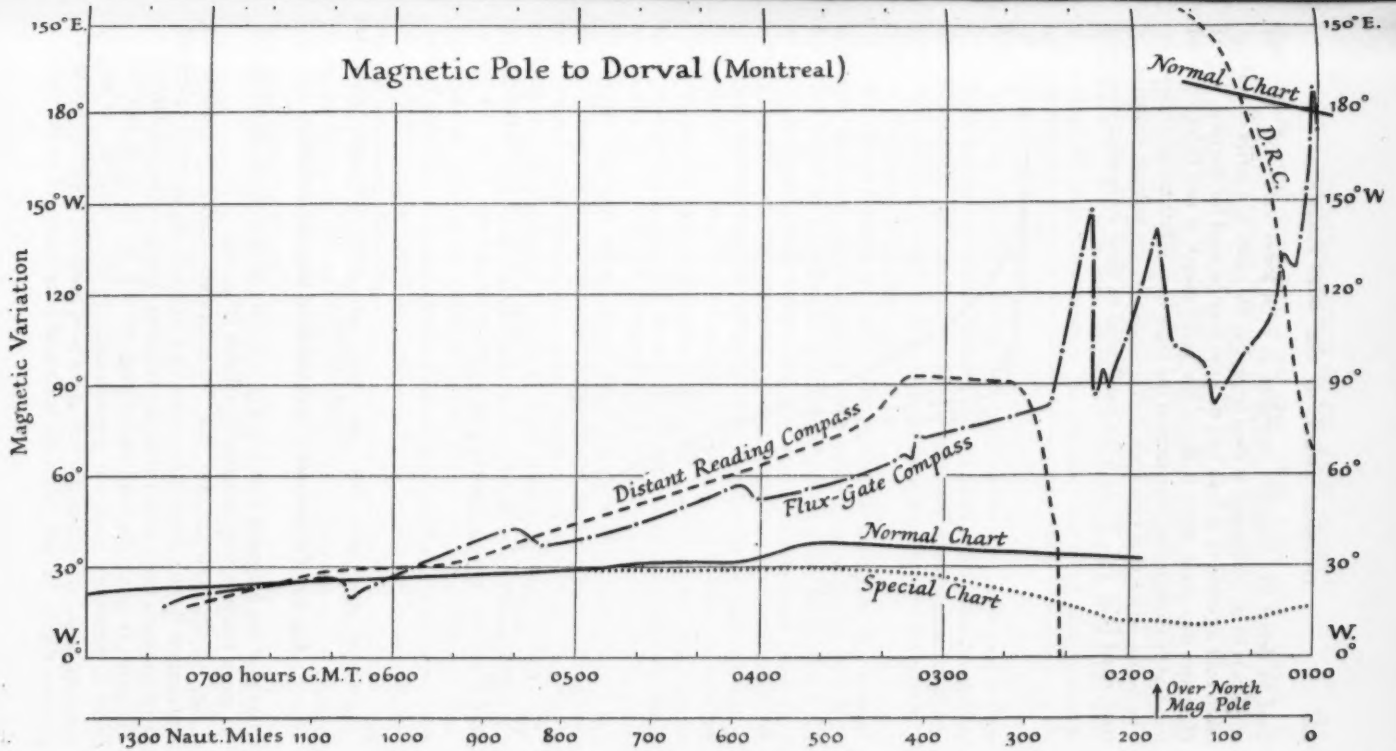


Fig. 12. Compass performance, II

used to detect the magnetic meridian at even lower values of "H." The amplitude of its oscillations is then large, but the mean of a series of readings taken over a period of at least two minutes may be used for steering. Fig. 13 illustrates this point, since it shows the performance of two lightly-damped non-stabilized magnetic compasses on the flight from White horse to Shawbury. The *x*-axis, or nautical mile scale, corresponds with the mileage shown on the track chart (Fig. 15). Though the oscillations of these compasses were large

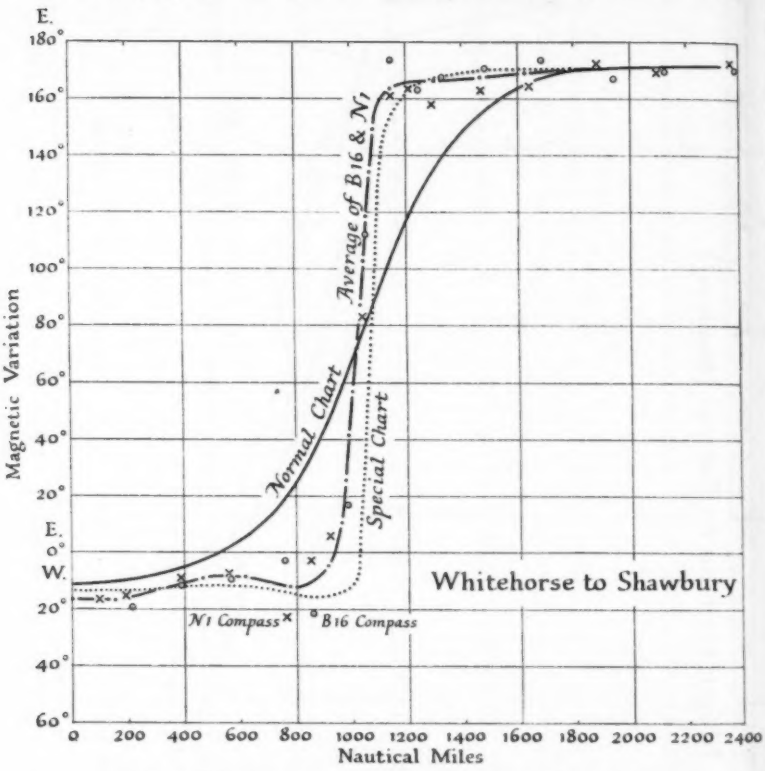


Fig. 13. Performance of non-stabilized magnetic compasses

when near the Magnetic Pole (see Fig. 10), they were of short duration, and the mean readings were remarkably reliable (Fig. 13).

Fig. 13 demonstrates also that the compasses tended to confirm the Astronomer Royal's deductions, since they followed the curve of calculated variation much more closely than the variation shown on the standard chart. The point at which the compasses swung towards the south on this White-horse to Shawbury track was approximately 77½°N., 105° W., or roughly 240 nautical miles north-north-west of the most northerly point reached on the previous flight. At both points the horizontal force measured on the aircraft's

magnetometer had dropped to 4 per cent. of its value over London. It therefore appeared (from a height of 11,000 feet) that the Magnetic Pole lay approximately midway between these two points, which tallied closely with the position calculated by the Astronomer Royal.

It must however be emphasized that this was the first attempt at an airborne magnetic survey in the vicinity of the Magnetic Pole; the results are therefore quite rough, and too scanty to justify any definite conclusions on the true configuration of the magnetic field. In so far as they support the theoretical shift of the Magnetic Pole, they point to the necessity for a full-scale magnetic survey of the area.

Radio

The radio equipment which we used for communications and navigation was standard. The only abnormal sets were two hand-generated transmitters which were carried in case of an emergency landing; we were perhaps fortunate in not having to try them out.

Reports of the Russian pre-war polar flights had indicated that normal short-wave communication should be quite satisfactory, although periods of depression might be experienced when short-wave transmissions would not get through. During such times they recommended long-wave (600–2000 metres), and claimed that greater than normal distances could be reached, due to the generally lower altitude of atmospheric interference phenomena within the Arctic.

Throughout the flights communications were maintained with one base or another on 6500Kc. (46 metres). Some direction-finding bearings were obtained on 6355 Kc. (47 metres), and a few in northern Canada on 500 Kc. (600 metres). No difficulty was experienced at any time. On the flight to the North Geographic Pole contact was maintained throughout with Reykjavík, the maximum distance being 1560 nautical miles. On the final flight from Whitehorse to Shawbury, the maximum distance at which Reykjavík could be heard was approximately 1600 miles, when flying at 15,000 feet in position 76° 10′ N., 110° 00′ W. At the same time Gander, over 2000 miles away, and Prestwick, approximately 2350 miles, could be heard at full strength. None of these stations could then hear the aircraft's transmission, and not until four hours later (at G.M.T. 0420 hours) did Reykjavík begin to pick up the aircraft, the distance then being 980 miles.

The radio direction-finding was good on the North Geographic Pole flight, but on the Goose to Dorval flight several erroneous bearings were obtained from the medium frequency direction-finding stations in northern Canada. The cause was not determined.

Of the radar fixing aids, Gee was used only in the British Isles, and Loran proved very useful in the normal transport route areas. A few Loran fixes were obtained north of Iceland, but the pulses rapidly became too difficult to identify, and though some appeared on the tube when close to the North Pole, the navigator could not obtain any reading from them. Since the stations were not sited to cover the Arctic, such a failure will not surprise the experts, though it was a disappointment to us.

The search radar, H2S Mark IIB, although not functioning faultlessly,

proved useful for navigation over much of the routes. It was found that it could not be used for detecting ice-bound coastlines, due to the strong returns from the sea-ice, but it was admirable for indicating leads of open water. Track and ground speed could be checked satisfactorily as the dark patches moved over the cathode-ray tube. It had been hoped that mountainous coastlines would show up, even though they were ice-bound, but unless the navigator looked out of the window first, he could not identify them.

Topography

As it was necessary to navigate by astronomical means, most of our flying was done at heights of over 10,000 feet. This meant that we were above cloud most of the time, and that only in clear weather could map-reading be attempted. From the observations we were able to make, the topographical maps varied considerably in accuracy. In a number of cases small coastal islands had been omitted, and in others the shape of the coastline was rather

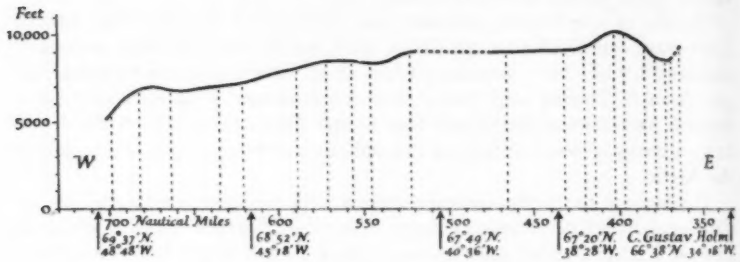


Fig. 14. Vertical section of Greenland ice-cap by radio soundings

different from that shown on the navigation maps. Pin-pointing the aircraft's position over low-lying, snow-covered land, surrounded by frozen sea, presented a difficult problem in map-reading; the bright glare did not help, and often the only solution was an astronomical check.

Photography was at a similar disadvantage through the prevalence of cloud and ice-crystal haze, and the lack of contrast in the Arctic landscape. It was further handicapped from the outset by the absence of proper photographic equipment; an extra fuel tank in the nose of the aircraft had taken the place of the usual installations, and miniature hand-held cameras had to be used instead. Nevertheless we brought back some interesting and unusual views, mostly of Greenland and the neighbouring islands.

To the geographer, perhaps the most interesting result was the series of soundings which we made of the Greenland ice-cap. On the flight from Reykjavík to Goose Bay, observations on the radio altimeter were recorded at frequent intervals as we made the east–west crossing. The radio altimeter gave the height of the aircraft above the ice-cap; the barometric altimeter (later corrected for pressure) gave the height of the aircraft above sea-level; and the two when combined gave an interesting vertical section of the ice plateau of central Greenland (Fig. 14). It was most unfortunate that a broken

aerial prevented a similar series of soundings being made on the second Greenland crossing from Etah to Scoresby Sound.

Sifting and analysing the thousands of observations made on the flights is a long task. Nevertheless the data we collected has already been put to use. The Royal Canadian Air Force in Ottawa has made immediate and practical use of our experience. On the Canadian combined Army-Air Force operation "Musk-Ox," now at work in the North West Territories, the supply-dropping Dakotas are fitted with navigation equipment designed on our recommendations. Again, plans are being laid not only in Canada, but also in this country and in the United States, for a much more extensive and fully equipped airborne magnetic survey of the Arctic.

It is clear that opening up the North American Arctic must be largely dependent on air transport. Before the late war, the U.S.S.R., Norway, and Denmark together had over two hundred weather-reporting stations north of the Arctic Circle; Canada and the U.S.A. had seven. This backwardness was due, not so much to want of necessity, for it had long been realized that weather reports from the Arctic would be of great assistance in forecasting in lower latitudes, especially over the North Atlantic, but to the difficulty of transportation. This is where the modern aeroplane, and modern navigation methods, can play an immensely important part. Areas which have hitherto been quite inaccessible can now be reached in comparative comfort and safety in a matter of hours. At the moment perhaps it would hardly be economical to run air transport routes across the Arctic; but looking into the future, it seems highly probable that before many years have passed flying across the Arctic will be as much a matter of routine as crossing the Atlantic by air is to-day.

DISCUSSION

Before the paper the CHAIRMAN (Mr. J. M. Wordie) said: Fellows of the Society will remember that we had in December a lecture from Wing Commander McKinley on the Arctic flights of the *Aries*. This afternoon we are to continue the story with a description of the technical details by Wing Commander Maclure. We were to have had a joint speaker, Wing Commander Winfield, who was responsible for the medical side of the expedition, but unfortunately he has been sent oversea.

Wing Commander Maclure then read the paper printed above, and a discussion followed.

The CHAIRMAN: We have with us the Astronomer Royal, who played a prominent part in the plans for the expedition. We should be pleased if he would be willing to take part in the discussion.

The ASTRONOMER ROYAL (Sir Harold Spencer Jones): I should like to comment on two points in Wing Commander Maclure's paper. First, in regard to the astro-navigation, as Wing Commander Maclure explained, there are special difficulties over the Polar area due to the convergence of the meridians, and the fact that the compasses become entirely unreliable, particularly when flying near the Magnetic Pole, so that it is necessary to be certain that the astro-navigation is based on sound methods. On the flight of the *Aries* the Greenwich grid method was used in practice for the first time; it is a fine method, and will undoubtedly form the basis of future navigation over Polar regions.

Secondly, the magnetic results are not, of course, in any way conclusive, but they are of particular interest to me because there is great difficulty in drawing isogonic lines over the Polar regions. The difficulty arises in the first place because the observations which are available are extremely scanty and widely distributed in time. Moreover, there is no information whatever upon which one can rely for secular changes over the Polar area. I did make an attempt over twenty years ago, which was published in the *Geographical Journal*, to improve the accuracy of the isogonic chart over the Polar regions.[1] As you have seen, the isogonals have two points of singularity, the Geographical Pole and the Magnetic Pole, and each of them has to pass through these two points. One can reduce the difficulty of drawing such complicated lines by dealing, not with the direction of the isogonals with respect to the meridian at the place of observation, but with projected lines of magnetic force. Such lines have only one point of singularity: the Magnetic Pole. The Geographical Pole is not a point of singularity, and therefore with scanty data it is very much easier to get a reasonably accurate interpolation of the projected lines of magnetic force, and then to read off the variation at different points, and from these values to construct the isogonic lines. But it did occur to me that one could get still better results, and construct iso-magnetic curves not only of equal declination or variation, but also of equal dip, of equal vertical force, and of equal horizontal force, by semi-theoretical methods. We have a fairly good knowledge of the Earth's field between about 60° N. latitude and 50° S. If one makes the assumption, and it is to some extent an assumption, that the Earth's magnetic field is due to forces which lie within the Earth and not outside it, one can analyse it by spherical harmonics, using only the data over the region of the Earth where they are reasonably accurately known, and then, by using coefficients from these harmonics, it is possible to compute the components of the magnetic field over other regions of the Earth.

It is possible to get a check on the assumption that the Earth's magnetic field arises entirely from forces within the Earth, since if the field was partly due to forces outside the Earth, the spherical harmonic coefficients deduced from the vertical component of the Earth's field would differ from those deduced from the horizontal component and the declination. Unfortunately, the weights of the determinations in the two cases are unequal. The weight from the vertical component is very much lower than that from the other two components, but the two coefficients agree very well within the probable errors of their determinations. This supports the view that the normal field of the Earth, apart from storm disturbance which comes from outside, arises from forces within the Earth. Thus it was possible to compute the iso-magnetic lines for the various magnetic elements over the Polar regions, and to derive positions for the North and South Magnetic Poles.

The derived position for the South Magnetic Pole was in close agreement with the observed position, but there was considerable discordance in the position for the North Magnetic Pole—which leads one to ask the cause. In the first place, the adopted position, based on Amundsen's observations in 1905, is not certain. It has been used for charting because nothing better has been available, but Amundsen based his determination entirely on observations made from the south. No complete survey of the area to the north-east or west side of his deduced position was made, and we know that in that region there are very considerable magnetic anomalies; it is possible to obtain by observation an apparent position of the Magnetic Pole which is considerably in error, because one happened to be in a region of magnetic anomaly.

[1] "The magnetic variation in the neighbourhood of the North Pole" (*Geogr. J.* 62 (1923) 419).

One of the advantages of making observations from the air is that the effect of such anomalies, due to deposits of magnetic material near the surface, are considerably reduced. The effect decreases with the inverse cube of the distance, so that if an aircraft is flying at 15,000 or 20,000 feet and the deposit is only half a mile or a mile below the surface, the effect is reduced to about 1 or 2 per cent. Therefore, magnetic surveys from the air offer the possibility of getting what one really wants in navigation, that is, the smooth Earth's field freed from the effect of these troublesome magnetic anomalies.

It seems that, in so far as one can draw any definite conclusions, the preliminary results from the *Aries* flights tend to support the view that the true position of the Magnetic Pole is appreciably to the north of the position that was assigned to it by Amundsen. I do not think Wing Commander Maclure would consider that anything more definite is justified at the present moment.

The expedition has definite value in another respect, and that is that it has demonstrated that magnetic surveys can be carried out efficiently and rapidly from the air. In this case the expedition was working over the most difficult region of the Earth's surface for that purpose, but the results do, I think, justify the view that aircraft have a great part to play in charting the Earth's magnetic field. Before the war the Admiralty were constructing a non-magnetic ship for magnetic survey work at sea, because of the lack of accurate data over parts of the oceans. The non-magnetic ship will get data accurately but rather slowly, and the cooperation of aircraft, which will get data far more quickly though perhaps not quite so accurately, but with the advantage that surface anomalies are largely smoothed out, will be of the greatest value and may in time entirely replace non-magnetic ships. The crew of the *Aries* are to be congratulated on the preliminary observations obtained under very difficult conditions.

Commander BURGESS: I should like to ask Wing Commander Maclure a question. I understand that you had to fly at about 15,000 feet, at which level the surface weather map can surely have been of little value, particularly in regard to wind?

Wing Commander MACLURE: It is true that it would have been an advantage to have known more about the upper levels, but the forecasters were not able to draw us a weather map for the 15,000–20,000 feet level, because there were no radio-sonde observations from Spitsbergen on which to base such a map. There were several reasons for choosing to fly at that height. It is a good operating level for the Lancaster; it is well below freezing at that altitude, with less risk of icing accretion; and, as we had to depend upon astronomical observations for fixing position, it was necessary for us to fly above most of the cloud. At 15,000 feet we were above all low cloud and most medium.

Commander BURGESS: I missed the first lecture on the subject, and I am wondering whether you experienced icing at temperatures well below that at which you would expect it.

Wing Commander MACLURE: Yes, the Captain several times reported icing at temperatures below the normal minimum of −18° C. But what was more remarkable was that on one occasion, on entering a very moist cloud, ice which had previously formed on the aircraft was literally washed off, although the temperature was below freezing.

There was one meteorological conclusion which I think neither Wing Commander McKinley nor I have mentioned. I was travelling in a train several months after the flights and, as I had nothing to read, I was dosing. Two people were discussing the weather, as usual, and one said to the other: "You remember the *Aries* flights to the North Pole?" Naturally I listened more intently. He

went on: "Well, I hear they found the North Pole had moved by about 500 miles, and that's why the weather in England has been so cold for the last ten years." "Yes," replied the other, "it's amazing what the R.A.F. can do."

The CHAIRMAN: We have listened to a most interesting account of the technical details of the *Aries* flights, and we are much obliged to the Astronomer Royal for the help he has given us in the interpretation. Wing Commander Maclure, with modesty, has not told us that he bears an honoured name in Arctic history, for it was a forbear of his, Sir Robert McClure, who, in 1853, was one of the first men to traverse the North West Passage. I noticed that the track of the *Aries* crossed McClure Strait and Winter Harbour, through which Sir Robert McClure made his passage, and it must have been a matter of personal satisfaction to Wing Commander Maclure to find himself crossing the path of that other McClure, but travelling in a much more comfortable and expeditious manner.

NOTE ON THE MEDICAL ASPECTS OF THE *ARIES* FLIGHTS

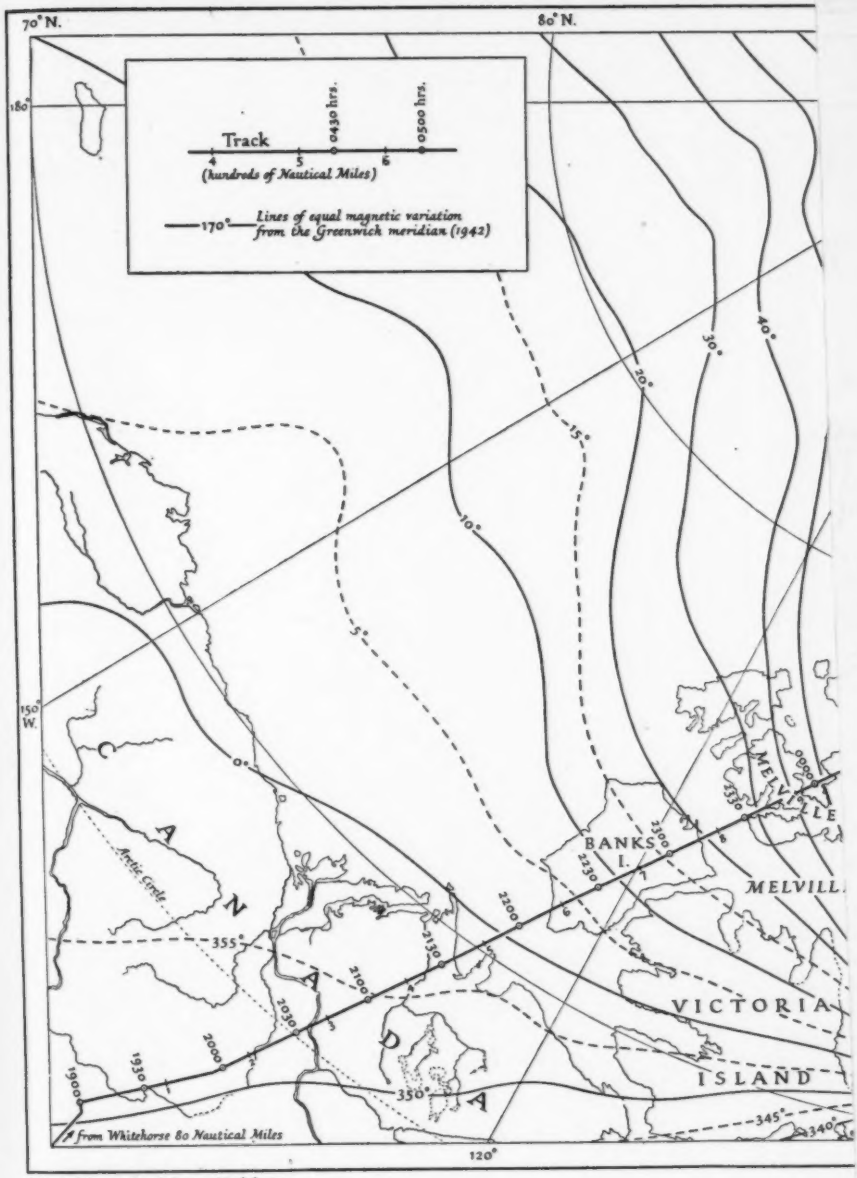
Wing Commander R. WINFIELD, D.F.C., A.F.C.

As he was unable to take part in either of the papers read before the Society on the Arctic flights of Aries, Wing Commander Winfield sends us the following account of the medical aspects of the flights

AS MEDICAL OFFICER on the *Aries* flights my main task was to investigate the reactions of the crew to the strain of long-range flying in the Arctic. If the symptoms and causes of fatigue were carefully observed and analysed, this knowledge could be applied when planning future flights in similar conditions. Another task was to select the equipment and rations which were carried on board in case of an emergency landing.

Selecting the crew on physical grounds was not difficult, because the routine R.A.F. medical examination for flying is sufficiently searching to ensure that the men who pass it are capable of withstanding the physical strain of long hours in the air. Special attention was however paid to dental examination, in case our stay in the Arctic was unduly prolonged. Each member of the crew was a specialist at his job and was chosen because he had the type of experience which fitted him for long and arduous flights of this kind.

It may be of interest to mention a few of the points which arose while preparing for the flights, before going on to discuss the observations made in the air. In choosing the emergency equipment and rations the most important consideration was that of weight; the principle I employed was to select articles which combined the best chance of survival with the minimum increase in the load of the aircraft. The weight of emergency clothing was much reduced by choosing clothes which could be worn both in the air and, if necessary, on the ground in Arctic conditions. As none of the crew had travelled on foot in the Arctic before, it was decided that the best plan would



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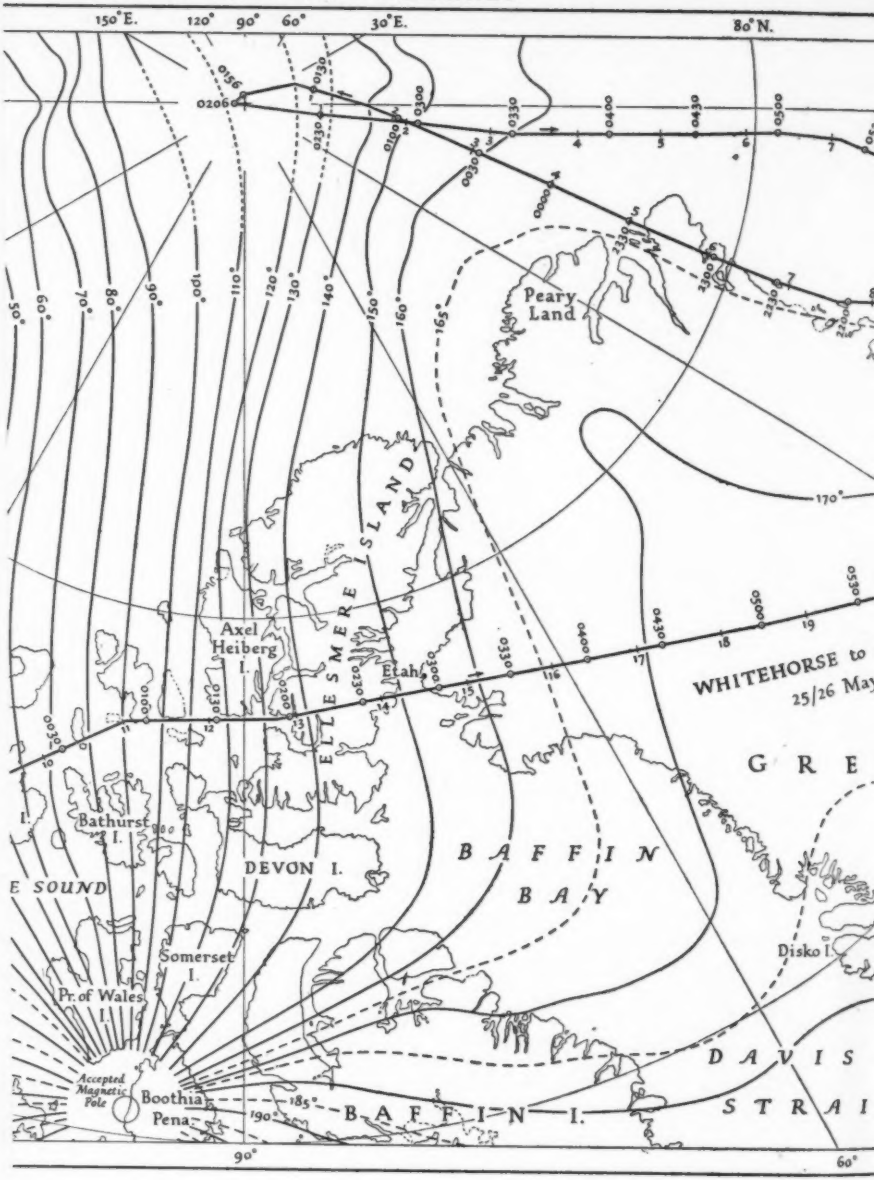
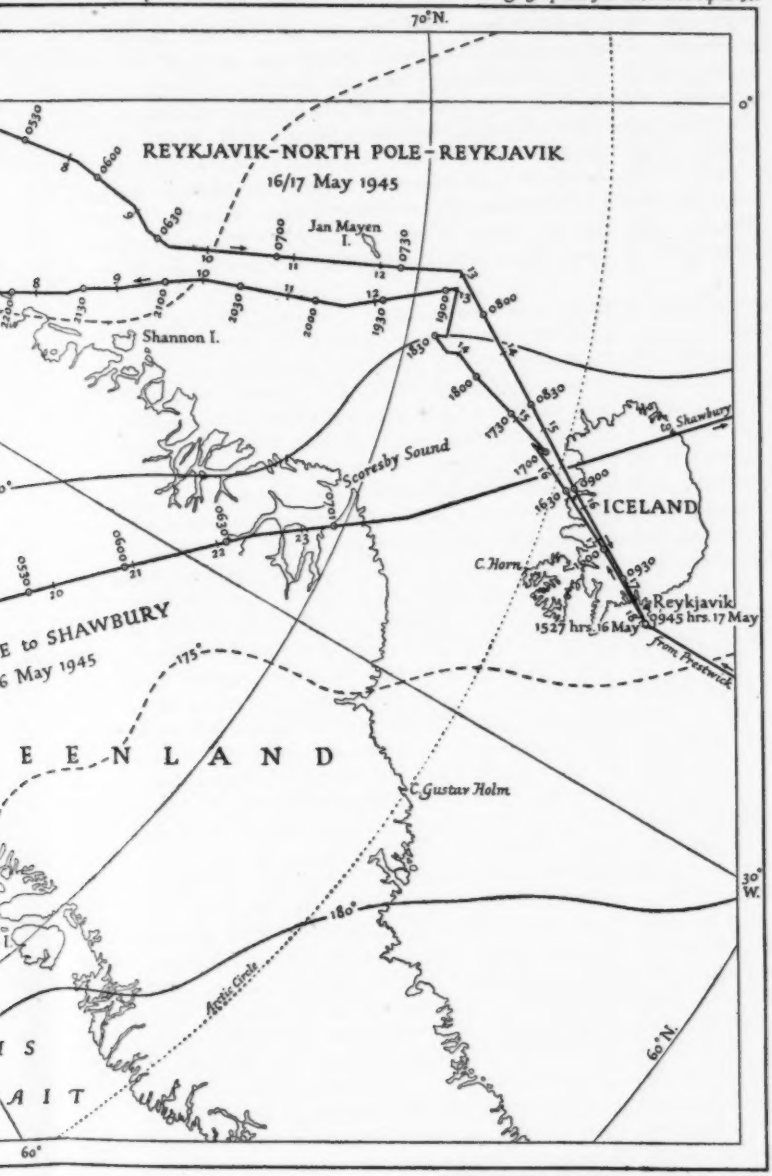

150°E.
120°
90°
60°
30°E.
80°N.
Peary Land
ELLESMERE ISLAND
Axel Heiberg I.
Etah
WHITEHORSE to
25/26 May
G R E
Bathurst I.
DEVON I.
B A F F I N
B A Y
E SOUND
Somerset I.
Pr. of Wales I.
Disko I.
D A V I S
S T R A I
Accepted Magnetic Pole
Boothia Pena
B A F F I N I.
90°
60°

Figure 15



THE ARCTIC FLIGHTS OF THE ARIES
McKinley & Maclure

be to remain near the aircraft until help arrived. This meant that much weight was saved in equipment, although it increased the importance of having a reliable emergency wireless transmitter for use on the ground. Wherever possible existing aircraft equipment was to be used for emergency purposes. For instance, the silk canopies of parachutes were to be substituted for tents, and for fuel for heating and cooking we were to rely on the contents of the petrol tanks. Even if a forced landing should be due to lack of petrol, a few gallons could probably be recovered from the tanks; but since aircraft petrol contains a high proportion of lead, it was necessary to modify the jets of our Primus stoves to prevent them from becoming fouled with a lead deposit.

Emergency equipment would probably have been of little use without a supply of food. Since the limit for rations was 500 lb., it was essential to obtain the maximum nutritive value for the least possible weight. Water can nearly always be obtained in the Arctic by melting snow or ice, so that much weight was saved by taking dehydrated foods. These were prepared by the Low Temperature Research Station at Cambridge and the products were compressed into blocks and stored in tin-plated containers. By this means a large variety of cooked foods were included in the diet, and an emergency ration was produced which weighed only 436 lb. including both the packing and the containers. This was sufficient to give the crew a varied diet of 3500 calories each per day for four weeks. The daily menu contained such widely different foods as curry, fish pie, scrambled egg, and tomato soup. The great value of dehydrated foods prepared by this method lies in the fact that, although the food has been cooked before dehydration, it retains its taste and flavour when reconstituted with water.

In the air I took special care to note any alteration in the behaviour of the crew which might indicate the onset of fatigue. I then attempted to discover what points in aircraft design, choice of equipment, and planning of the flight contributed to this. It was obvious that fatigue would have been very much reduced if the flights had been made in an aircraft specially designed for Polar flying, instead of in a standard heavy bomber merely modified for the purpose. One of the more important of these modifications was an increase in the oxygen supply of the aircraft, carried in forty-five oxygen bottles with a capacity of 750 litres each. These were stored both in the nose of the aircraft and amidships. It was noticeable that on these very long flights the onset of fatigue could be delayed by breathing oxygen even at altitudes just below 10,000 feet. It was also evident that when flying at oxygen heights more oxygen was required if the subject was exposed to extreme cold. Cabin heating kept the cockpit at a reasonable temperature, but the fuselage was unheated as it is not normally occupied in the standard bomber. The observers working here experienced severe cold. Their efficiency was reduced both by the fall in body temperature and by the extra exertion and discomfort caused by wearing bulky clothing. It was impossible for them to wear electrically-heated suits because the current was not available, as the aircraft generators were already taxed to their full capacity.

It was interesting to observe that sleepiness was not a predominant sign of fatigue, although on the flight to the North Geographical Pole some of the

crew were without sleep for fifty-six hours. The flight lasted for just under twenty hours and was preceded by a period of furious activity while the necessary preparations for the flight were being completed. This unusual wakefulness was probably the result of a combination of circumstances: the incentive of making new discoveries and the loss of a sense of time caused by perpetual daylight played their part. It is easy to understand that the absence of darkness coupled with the dazzling brightness of sun and sky should add to fatigue without increasing sleepiness.

A flight such as this, when undertaken for the first time, is arduous and fatiguing and at the same time exciting and stimulating. But there is every indication that when Arctic flying becomes a routine of civilian aviation neither passengers nor crew will be subjected to any stresses to which they cannot adapt themselves with ease.

A VISIT TO SOUTHERN KURDISTAN

WITOLD RAJKOWSKI

I SET OUT FROM Kirkuk in October 1943, sharing the front seat of a taxi with a fat and friendly local merchant. We crossed the dry river-bed which divides the town, and then on our right, above the bazaars, rose the *Qala'a* or Citadel, the oldest quarter of the town, a huddle of houses on a grey mound. In the distance the leaning minaret of Takkia Talabani surmounted another quarter. As we left the town, a long range of almost uniform, rounded summits stretched before us across the whole horizon. Our road climbed towards a pass in the chain, a gorge between slopes overgrown with dry grass. At the top a wide panorama of hills, a disorderly mass of crests and rifts, yellow and rust-coloured, came into view. Behind us, over the tops of the range which we had just passed, two tongues of flame and a cloud of smoke marked the oil refinery at Baba Gurgur. A moment later we plunged among the hills and skirted a small village called Qara Anjir (Qara Injir),[1] a group of low cabins, with flat roofs made from earth and branches. For a time we followed the course of a stream in a refreshing green valley between groves of poplars.

An hour's drive over the winding road brought us within sight of Chemchemal. We stopped just short of the town at a *chaikhana*, or teashop, where several Kurds in dark turbans, with huge knives in their sashes, sat on benches. The local people belong to the Hamawand tribe, now peaceful agriculturalists, but once famous as robbers and fighters. The interior of the *chaikhana* was blackened with soot, the only bright object in the room being a large brass samovar in one corner. From within we could see opposite a curious oval mound, all that remained of an old Turkish citadel.

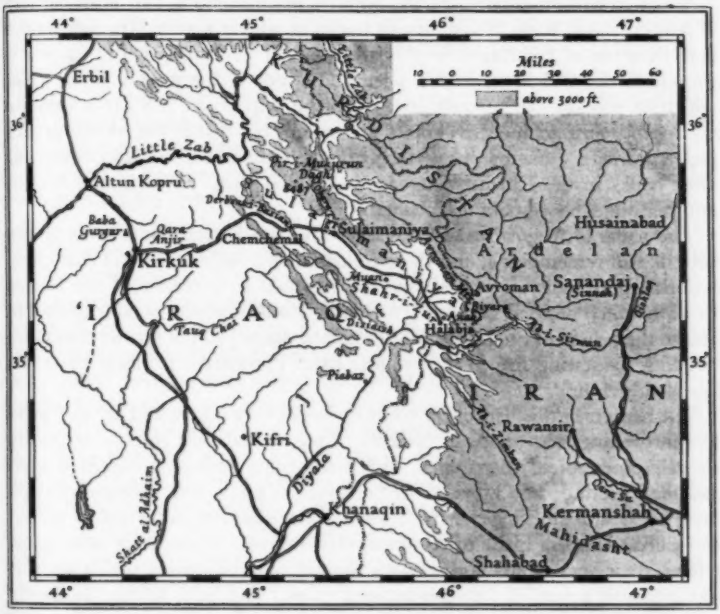
Leaving the *chaikhana*, we skirted Chemchemal and entered a tangled country of high ridges and deep-cut, steep-sided gullies. The tops were

[1] The names in the text and on the map are taken from the War Office 1/M sheets GSGS 2555; the names in brackets are the author's transliterations from the Kurdish.

covered with a yellow brush of dry grass, but the slopes below were bare and brick-coloured, and in places so steep that they resembled red walls above the narrow ravines.

Presently we emerged from this broken country on to a wide plain, rising gently towards a heavy range of grey mountains which filled the skyline. As we approached it, the range towered above us, its face broken by slabs of stone, its jagged edges sharp against the sky. Ahead of us, the mountains were divided by a deep ravine, resembling a great open gate, the sides of which bristled with pointed rocky teeth. The opening had once been closed by a wall, of which there were now only a few crumbled remains.

This was the famous Derbent-i-Bazian pass. A police fort with a tower



stood on the plain near the entrance. We passed it by and drove through the natural gateway, between slopes which, though steep and boulder-strewn, were overgrown with grass. A great white stone, about 200 yards above the road, was pointed out to me as the spot where Shaikh Mahmud had been captured by British troops in 1918. At the far end of Derbent-i-Bazian was a second police post.

Our road, after twisting among hills for some time, turned north and led through a second pass, much less imposing than the first. From the summit we looked down on a large, flat-bottomed valley, overshadowed on the farther side by a high range, which terminated on our left in the great angular head of Pir-i-Mukurun Dagh (Pira Magrun). Some distance to our right the town of Sulaimaniya was visible as a whitish patch.

We traversed the valley obliquely, through fields of stubble, and crossed the dry, gravel-filled bed of the Obara Chai, between the groves of poplars which line its banks. Before us was the main street of Sulaimaniya; large, well-paved, and bordered with low one-storey houses. At the far end we came to a large square, where four roads met. On the north side was the *Serai*, or headquarters of the local authorities, a heavy building of stone masonry, on the site of which the old palace of the Baban princes had once stood. On the opposite side of the square were two crowded *chaikhanas*.

We stopped for the night in Sulaimaniya, and I was conducted to the best hotel, an old building with a courtyard in the centre, surrounded by long balconies, on which many people sat smoking pipes and drinking tea.

While in Sulaimaniya I had the opportunity of visiting two Kurdish men of letters: Sayid Rafiq Hilmi, one of the most widely known Kurdish writers and Director of Education in this area, and Hajji Taufiq, better known as Piramerd, the Old Man, writer, poet, and editor of the weekly paper *Zhiin*, which he produces on a small press with the help of one boy. It is true that not more than four hundred copies are issued, but this is due to the general paper shortage. Sulaimaniya is the centre of Kurdish culture, and in the past most books in the Kurdish language originated here. Nowadays, I believe, nothing but school-books are printed.

The name of Major Soane,[1] or rather Ghulam Hussain as he was known here, is still remembered, and there remain many visible traces of that extraordinary personality. I was shown the fountain in a corner of the bazaar, beneath which he used to pray. The bazaar itself, it seems, was presented by him to the people of Sulaimaniya after he had destroyed the former crumbling building by setting fire to it at night. Even Piramerd's printing press was founded by him.

The bazaars in this part of the country do not vary much, and seemed to me less interesting than those of Kirkuk. They consist of a jumble of narrow streets, some roofed, others open, with small shops displaying imported wares and local produce side by side. In Sulaimaniya I saw bright-coloured skull-caps, socks and stockings of thick wool, plain white or patterned in purple, and canvas slippers made in Avroman (Haoraman). There were also dagger sellers, their waistbands stuffed with the big, curved knives which form so indispensable a part of Kurdish national dress. The local Kurds, unlike the people farther north, mostly wear long gowns, although baggy trousers are also quite common. Here, as elsewhere, the headdress is a big turban with long fringes. The women wear flowered cotton dresses of European origin, and white muslin veils, which however do not cover their faces but are thrown back over their turbans. Conspicuous in the throng were Qadri dervishes, with their thin bearded faces and long hair, which is often plaited and tucked into a small turban wrapped around a high conical cap.

Apart from the two main streets, Sulaimaniya consists mostly of narrow lanes and close-packed, one-storey houses, with flat roofs, and walls plastered with yellow clay. Within, many of these houses have quite spacious courtyards. A little to the south-east of the town lies a long stony ridge, where the white cupolas of tombs gleam among the mulberry trees. Here also are

[1] E. B. Soane, 'To Mesopotamia and Kurdistan in disguise.' London, 1912.

numerous white tombstones set up in the red pebbly earth, many of them elaborately inscribed, others decorated with small pieces of broken glass and pottery.

I did not stay long in Sulaimaniya, but left the following afternoon in a lorry bound for Halabja. The country around Sulaimaniya is undulating, with high ranges in the distance, and everywhere the grass was dried and yellow. We stopped by the way at a *chaikhana*, its several trees making a pleasant patch of green, and again at the police post of Muan (Mawan), where our lorry was loaded with tree-trunks. Some six or seven miles beyond Muan there rose on our right an ancient mound, similar to those on which the towns of Kirkuk and Erbil stand, separated from us by a wide expanse of marshland, round which our road ran in a wide bend. A little farther on we stopped at a point on the road below a small village. Women with petrol tins were fetching water from a stagnant pool over which mosquitoes swarmed. (Malaria is a plague throughout the mountainous part of 'Iraq.)

Shortly afterwards we entered the rolling plain of Shahr-i-Zur, bordered on the east by the great mountain mass of Avroman. Here and there groups of black tents broke the expanse. In the distance a green patch indicated the gardens and poplar groves of Halabja. We entered the town by the main street, crossed the small square at its centre, and turned off into a courtyard.

During my stay in Halabja, my host was Hamid Beg Jaf, a local notable, who owned a large two-storey house below the town, and to whom I had a letter of introduction from his son, a student in Baghdad. From the outside the building resembled a fortress, but within it stood on three sides of a garden courtyard, open to the north to allow a magnificent view of the distant Avroman mountains across the Shahr-i-Zur plains. On a level with the upper storey of the house, a long gallery ran round the inner walls. Opening on to it were spacious rooms, comfortably furnished in European style. In one of these, shortly after my arrival, I was entertained by my host to a copious meal of Kurdish fare; in another my bed of clean sheets and many quilts had been spread upon a carpet. During the evening I accompanied Hamid Beg to the Nadi-Al-Mu'adhdhafin, a newly opened club for local government officials, consisting of two small overcrowded rooms. In the larger of the two gambling was in progress amid clouds of tobacco smoke; the other was reserved for conversation and drinking *'araq*, which was in liberal supply. Here I was introduced to a number of local dignitaries, including the district superintendent and the medical officer. Most of them were of striking appearance, and some were richly clad in national dress.

Next day I visited the market-place, where I found crowds of peasants buying and selling fruit, vegetables, chickens, clothing, and kitchen utensils. The bazaar was a rectangular stone building with a cupola roof. The stalls were mere niches on either side of narrow intersecting passages, where merchants squatted on their counters, with bundles of coloured scarves, women's dresses, skull-caps, woollen stockings, and other goods, hanging above their heads.

Most of the larger buildings in the town lay on the farther side of the main thoroughfare. Here were the houses of the rich, set in shady gardens, and also the government offices, the prison, and hospital. At the hospital most of the

patients were, as I expected, malarial cases. Fields of tobacco plants spread out behind the town.

From my host, Hamid Beg, and from his cousin, Hasan Beg, I collected some facts about the tribe of Jaf. Hasan Beg possessed a collection of Arabic, Turkish, and Persian books, mostly historical, so that we had many mutual interests to discuss. The Jafs are not mentioned in 'Sharaf-Nama,' the great Kurdish history composed by Sharaf Khan Bitlisi, although he wrote of tribes farther south. Probably their chiefs acted in the name of the Walis of Ardelan, to whom they were subject, so that their doings were ascribed to them. The first recorded chief of Jaf was Dhahir Beg, who was invited by one of the Baban rulers of Sulaimaniya to transfer from Ardelan to the province of Shahr-i-Zur and to be responsible for its defence. Dhahir Beg accepted this offer, and, taking with him the greater part of the Jaf tribe, settled in the district of Diziaish. At this the Wali of Ardelan was greatly displeased and decided to punish the headman of Jaf. To all appearances he undertook a peaceful pilgrimage to Karbala, and stopped on the way with his retinue at a place called Piabaz on the Diyala river, where he invited Dhahir Beg to visit him. Dhahir Beg, not suspecting treachery, went with only a small escort, and was immediately seized and put to death. His grandson, Kai Khosrow Beg, was once host to C. J. Rich, the British resident at Baghdad in 1820. Despite this treachery his tribe remained under the jurisdiction of the Baban princes, though they continued to visit Persia in summer, as they had pastures in the vicinity of Sinneh (Sina). Indeed they have continued this practice every year until recent times, and have only temporarily discontinued it because of difficulties raised by the Persian government. Several branches of the Jaf tribe, such as the Waladbegi, Qobadi, and Babajani, have remained on Persian territory. Since time immemorial the Jafs have been a wholly nomadic tribe, but within the last few years they have begun to settle, and in a short space of time a number of their Begs, or members of the ruling family (Begzade-i-Jaf), have become rich landowners. Of the several Jaf chiefs living on 'Iraqi territory, Kerim Beg appeared to be the most powerful.

As I wanted to see something of the Avroman mountains, I decided to visit the village of Biyara, the residence of Shaikh 'Ala Ad-din, religious chief of the Naqshbandiya and Qadiriya congregations. These religious leaders still enjoy a strong influence among the people, although there is no doubt that it is waning, and that the tribal bonds are stronger than the religious.

At the wish of the *qaimmaqam* (district superintendent), I was accompanied by a *dauriya*, or police patrol, of two mounted policemen. A pack-mule had been assigned to me, but, seeing my annoyance, one of the policemen offered me his horse, so that I set out well mounted. As we left Halabja, we were overtaken by another horseman, a Kurd on a white steed, which carried a high narrow saddle, and harness decorated with fringes. The rider was dressed in Kurdish national dress, and a handsome turban of black, red, and green. His cast of features were of a type commonly met with among the Avromani tribesmen, who are more nearly related to the Persians than are the other Kurds, and speak a dialect of their own.

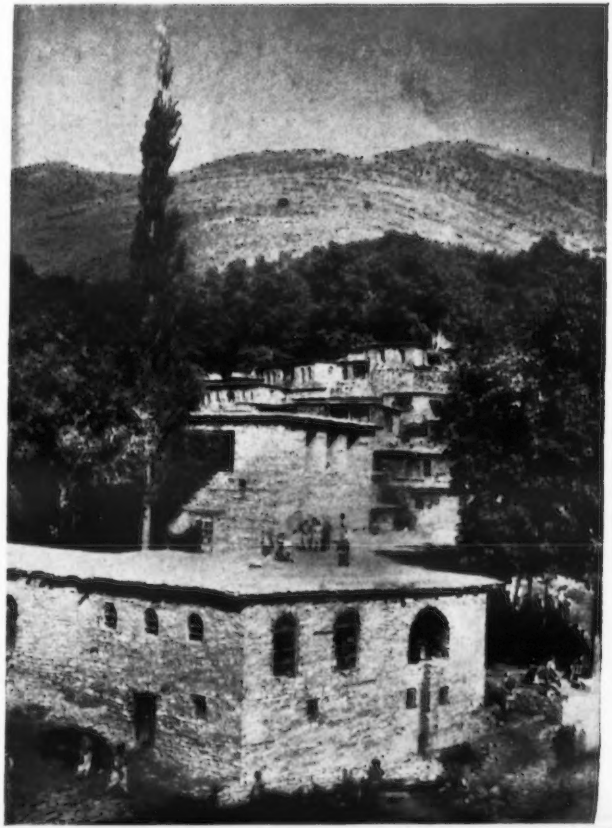
We travelled slowly across the undulating plain towards the mountains. At one point we passed a grove of big trees in a shallow valley, where peasants

Avroman mountains

Market-place at Halabja

Shaikh 'Ala Ad-din

Horseman on the Shahr-i-Zur plain



squatted beside a water-tank. Another group were gathered around the carcase of a freshly slaughtered sheep which they were helping to skin. There followed another stretch of the same drab, dun-coloured country, before we reached a second valley with thickly growing mulberry trees. On the incline stood a small *chaikhana*, consisting of one tiny blackened room, with banks of beaten clay to serve as seats. In the hollow of the valley we rode beneath a dark tunnel of interwoven creepers. Emerging on the farther side, we crossed a series of ridges, while the mountains rose ahead of us in a heavy mass, spotted with dark tufts of scrub oak and tinted by the setting sun.

We reached at last the first spurs of the Avroman, and could see behind us the small villages of the plain, set in patches of dark green trees. Before long we entered a deep, wooded gorge, where autumn colouring had already set in among the thick, grey-trunked walnuts. Far beneath our feet we could hear the roar of a great river, while above us towered the main mass of Avroman.

Soon the village of Biyara appeared. The grey stone houses, with their flat roofs, wooden-barred windows, and numerous balconies, rose in close-ranked terraces, with crooked alleys winding up between their walls. Here the policemen left me to go to their post, high up the mountain-side above the village, having first called a small boy to escort me to the shaikh. He ran ahead, and I followed, down a narrow alley rough-paved with stones, to the nearest house on the farther side of a stream, where several men were already gathered to greet me in the name of the shaikh.

I was ushered through a small anti-chamber, where I stumbled on a row of shoes and slippers, into a room on a lower level, with bare plastered walls and worn red carpets on the floor. Several figures stood against the walls, and from a mattress in the far corner the shaikh himself rose to welcome me—a small, bent man, with a long white beard cut in two barbs, dressed in a white turban and grey gown. He greeted me in Arabic, and invited me to be seated on another mattress which was hurriedly spread beside his own. Here we sat and conversed until the shaikh left me to say his prayers. At first he seemed to mistrust my motive in visiting him, and was evidently reassured to learn in the course of conversation that I was interested not in his politics but in the life and customs of his people.

During the night I woke several times to hear many voices shouting hysterically a monotonous "Hai-hu! Hai-hu!" from the house on the opposite side of the stream. The following morning I woke late, and out of curiosity visited the house, which I found to be a *khanaqa*, or monastery, a big building of strong masonry, with a courtyard at the centre. As I entered the yard, several men passed by, bearing a human corpse on wooden poles—no doubt the object of the rites which had awakened me. A little farther up the hill-side, the rattle of an electric dynamo mingled with the roar of the stream. This had been installed by Shaikh 'Ala Ad-din, to provide electric light for the people of Biyara.

As I intended to return to Halabja that day, I decided to visit the police post on the mountain-side above the village. I reached it by climbing the muddy stone lanes of Biyara, until I saw the 'Iraqi flag fluttering from the mast. Here I had a fine view of the village below me, its terraced roofs partly

screened by trees. The walnut groves in the valley beneath made a belt of green, yellow, and red across the buff-coloured mountain-side.

The *'arif* in charge of the post greeted me cordially, and returned with me to the village, which we reached again by descending the labyrinth of steep village alleys. Passing the walls of the *khanaka*, we stopped at the adjoining *chaikhana*, where a great walnut tree provided shade and comfort for the villagers lounging on the benches. Here I had a chance of studying in more detail the national dress, which is similar to that worn in other parts of Kurdistan with a few distinctive touches. It comprises, first a white cotton shirt, with long full sleeves; over this, baggy trousers and a tight jacket buttoned up to the neck; and then another jacket, open at the front, but held in place by a wide cummerbund. The light-brown cloth of which coat and trousers are made is woven locally, the best quality being pure goat hair. Generally a waistcoat of thick felt is also worn; and in cold weather a voluminous cloak, also of felt. The head is first covered with a skull-cap, and then wrapped in a large turban.

I re-entered the house of Shaikh 'Ala Ad-din in company with some of the villagers, and was the witness of a curious little ceremony. Led by the *'arif*, they advanced one by one, and kneeling before the shaikh, kissed feet and hand, and then stood aside with hands folded and head bent in utmost humility. There followed a lengthy council, in which they spoke together in low voices. Turning to me, the shaikh explained that his enemy, Mahmud Khan Dizly, an Avromani chief from the Persian side of the frontier, had invaded one of his possessions and turned the peasants off the land.

Eventually I left Biyara, mounted on one of the shaikh's own horses, and accompanied by one of the *'arif's* men—a fierce-looking Kurd, with a Berthier rifle slung over one shoulder. Sadly, I took leave of these friendly people, and started my horse moving on the homeward journey.

VITICULTURE IN BELGIUM

STANLEY W. E. VINCE

IT IS NOT always realized that Belgium, although primarily an industrial country, lying entirely north of the economic limit of outdoor vine cultivation,[1] ranks nevertheless as an important producer of table grapes, the entire output being under glass. About 5 per cent. of the total world output of table grapes is under glass, of which a large proportion comes from Belgium and Holland.

Open-air cultivation, at no time important, has now almost disappeared, except in a few sheltered localities in and around the middle Meuse valley between Namur and Dinant, and around Huy. The acreage declined from 300 hectares in 1865 to 80 hectares in 1910, and the present figure is insignificant. It represents a hobby rather than a commercial undertaking, the fruit being for domestic use.

Commercial cultivation under glass dates only from 1865, when the first glasshouses or *serres* were established by the Sohie brothers at Hoeilaart about 10 miles south-east of Brussels.[2] Recent agricultural statistics do not distinguish between grapes and other glasshouse produce, but the 1929 returns (the last year in which a distinction was made) show 293·9 hectares, or 726 acres, of grapes under glass.[3] It is known that great expansion occurred up to 1932, and the present acreage must be at least 350 hectares or some 900 acres.

The map of grape production (Fig. 2) is based on the 1929 returns, and shows that the Hoeilaart district south-east of Brussels was then still, as it is to-day, the centre of the industry, with minor production all round Brussels and some of the larger towns such as Ghent, Charleroi, and, to a lesser extent, Antwerp. Clearly the Ardennes and most of the Campine region of the north are negative areas, though a few large nurseries occur in the eastern Campine near Peer. The remarkable concentration near Brussels is such that, of the Belgian 1929 total of 293·9 hectares, no less than 244·9 or 83 per cent. were within the three cantons of Ixelles, Louvain, and Wavre, immediately south-east and east of Brussels.

This now highly important industry is primarily the outcome of economic and historical forces, conditioned by certain broad geographical factors, which include the dense population, both urban and rural, the high natural soil fertility, the long-standing tradition of intensive cultivation, and the favourable position at an international crossroads. These constitute the effective geographical background to Belgian viticulture, and it would be a mistake to attempt an absolute correlation with local factors of soil, climate, or local markets.

Intensive agriculture in the Low Countries was originally based on the

[1] The "grape line" runs approximately from Nantes north-east through Paris, Laon, Luxembourg, and Cologne, thence east-south-east to the Sea of Azov.

[2] 'Encyclopédie agricole belge,' Vol. 1, p. 809.

[3] 'Recensement agricole belge,' 1929.

extremely fertile loams and sandy loams which prevail over most of Flanders and Brabant; on the large demand exerted by prosperous towns such as Bruges, Ghent, Tournai, and Antwerp, as early as the thirteenth century; and on the availability of manure and town refuse. In modern times the tradition has been strengthened by the increase in population, which in 1940[1] averaged 706 per square mile, the densest in Europe. Population pressure fostered the intensive cultivation of vegetables and fruit, of which grape culture is one aspect. Beginning at Hoeilaart as a part-time undertaking supplying nearby Brussels, its eventual development into a major industry was

Figure 1

stimulated by this large market of almost one million. The favourable position of Brussels on main international routes drew the industry into international trade and encouraged further expansion. Within easy reach by land routes east and west were densely populated industrial districts of western Germany and northern France. The British market was easily reached via Antwerp or Ostend, and, after 1923, by the Harwich-Zeebruge train-ferry, which soon proved the most effective means of transport. Norway and Sweden were a comparatively short journey distant by sea, and could be reached also by overland routes through Germany and Denmark.

There is little cultivation within the Campine, where the sandy terrain supports a scanty population, often only recently settled. Intensive agriculture

[1] The latest year for which official population figures are available.

is to be found only on the western fringe towards Antwerp. Except for small developments in the middle Meuse valley near Dinant, and south of the main watershed in the Arlon district, grape cultivation is negligible.

The Hoeilaart-Overijsche producing area is slightly undulating and from 180 to 400 feet in elevation, draining in a general north-east direction to the Scheldt system. Its soils are light loams, heaviest on level tracts and on the more gentle southern slopes. The interfluves are especially well-drained and their friable soils are suited *par excellence* to intensive cultivation. Immediately to the north-west is the large crescent-shaped Forest of Soignes, con-

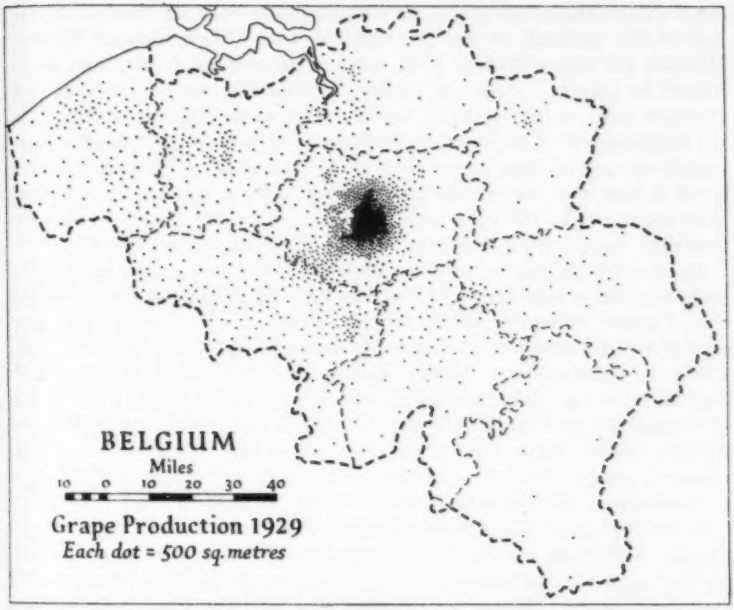


Figure 2

sidered by growers as a valuable windbreak, although conclusive meteorological evidence for this is not available.

The glasshouses occur chiefly on small, specialized holdings of one or two acres, and in this Hoeilaart area are so concentrated that the entire landscape appears glass-covered. It is estimated that two average-sized grape *serres* are sufficient to support a family. There are also a number of part-time growers who supplement their returns with other work, often in nearby Brussels.

In the province of Brabant, which includes the principal producing area, the average capacity of a grape *serre* is 134 square metres, and no less than 79·8 per cent. of the grapes are grown on holdings smaller than 1 hectare or about 2·4 acres. This shows a highly specialized and intensive system of cultivation, contrasting, for example, with the Ardennes where, in the province

of Luxembourg, the average grape *serre* capacity is only 36 square metres, and only 36·6 per cent. of the total output is on holdings of less than 1 hectare. In Limburg province, which includes much of the Campine, the difference is even more marked: 70 per cent. of the total output is grown on holdings of 100 hectares or larger, and only 13·4 per cent. on holdings of less than 1 hectare, showing that the small production occurs in small plots on larger holdings, as a sideline to other forms of agriculture. Elsewhere in Belgium the production of grapes is associated with small specialized holdings as in Brabant.

A study of the relation between grape cultivation and other forms of glasshouse culture shows that grapes are relatively more important in the southern half of the lowlands, in the provinces of west Flanders, south Brabant, Hainaut, and part of Namur. Here, some 35 per cent. of the total area under glass is for grapes, while in some cantons within this area the rate is as high as 75 per cent., as it is in the canton of Ixelles which includes Hoeilaart. In the northern half of the lowlands, both east and west of the Scheldt, grapes usually occupy less than 15 per cent. of the total glass, which in these sandy tracts is best used for strawberries, flowers, chicory, asparagus, and other close-set crops. In the high Ardennes the very limited glass is chiefly for local early vegetables, and the proportion of grapes is extremely small.

In the main, Belgian *serres* differ from the Dutch in having a heating installation, coal or coke fired. This enables early varieties to be matured at the end of March or early April, while late varieties can be kept on the vines throughout the winter and marketed as late as May of the following year, giving the grower a useful overlap, though the heating costs of these extra-seasonal crops may amount to 40 per cent. of the total costs. The most usual early varieties are Frankenthal and Royal, and the chief late varieties are Muscats and Colmans. The main crop, raised with moderate heating, is marketed from November to January, with a secondary maximum from June to September. Supplies are lowest from February to May.

In the 'eighties of last century sales were chiefly made direct to growers in nearby Brussels or Antwerp. Nowadays, most of the exports, which still amount to at least two-thirds of the production, are handled by specialists established in the Brussels and Hoeilaart area, who buy direct from growers and grade and ship the produce. The home market is supplied partly by growers' cooperative selling bodies, who sometimes act also as buying agencies for coal, glass, and other growers' requisites. In 1927 the total production was valued at 60,000,000 francs, of which 48,000,000 francs worth was exported. Since 1927 the volume of home sales has increased. In recent years a skilled labour shortage has been felt, attributed to the pull of Brussels industries.

Table 1 [1] shows that in 1930 Belgium ranked twelfth among world exporters of table grapes, the chief being Italy, Spain, the United States, and France. For the three years 1927–29 Belgium's relative position was the same, with exports averaging $2\frac{3}{4}$ million kg., compared with only $\frac{3}{4}$ million kg. for the pre-1914 years. The United Kingdom normally takes most of the Belgian grape export, chiefly high quality dessert grapes which arrive during the

[1] 'Le viticulteur belge,' 1934, p. 79.

Table 1. World export trade in table grapes (in 1,000 kgs.)

	1911–13	1927–29	1930
Italy	22,110	24,730	45,320
Spain	46,260	47,930	38,520
U.S.A.	—	21,110	22,250
France	11,580	37,270	22,130
Hungary	—	3,430	17,640
Algeria	15,600	5,160	8,020
Holland	300	5,350	7,410
Greece	690	6,400	7,300
Argentina	—	3,300	5,420
Rumania	—	5,260	3,840
Portugal	6,800	4,370	3,380
BELGIUM	770	2,770	2,790
Bulgaria	20	1,200	2,770
South Africa	—	2,220	2,510
Cyprus	—	1,720	1,480
Turkey	—	200	380
Palestine	—	380	370

winter months of December and January. Scandinavia, Holland, Germany, France, and the United States also import considerable quantities. After 1931 the British tariff of 3*d.* per lb. on glasshouse produce caused a striking decline in Belgian exports, while Spain and South Africa, both open-air producers, gained a far larger share of the British market.

Table 2 [1] gives the sources of grape imports into Britain for 1934, month by month. In this, a typical pre-war, post-tariff year, Belgium supplied

Table 2. British grape imports, 1934 (in cwt.)

	Belgium	*Holland*	*Channel Islands*	*Spain*	*South Africa*	*Rest of British Empire*	*Other Countries*
January ..	4,798	16	—	1,271	534	—	7,205
February ..	3,298	3	—	—	15,336	—	191
March ..	706	—	—	—	57,684	146	735
April ..	179	—	—	—	36,468	1,960	4,094
May ..	296	—	—	—	16,572	1,160	4,755
June ..	1,817	219	4	—	4,026	48	1,034
July ..	2,733	2,480	233	2,423	16	13	27
August ..	2,537	6,131	951	23,043	—	—	28,827
September	2,135	7,274	2,753	116,215	—	—	59,876
October ..	1,998	10,082	5,335	217,127	—	—	18,367
November	2,747	5,539	1,510	210,260	—	—	14,511
December	5,567	1,267	144	117,541	—	104	24,449
Total ..	28,699	32,908	10,937	688,144	129,350	3,455	166,214

[1] 'Le viticulteur belge,' 1934, pp. 58–9.

2·8 per cent. of the total, Spain alone provided 68 per cent., and South Africa 12·8 per cent. Belgium's share in the market was greatest in the winter months of January and February, with 34 and 17 per cent. respectively, after the open-air production of European countries had ceased, and before the main flood of South African grapes had begun to arrive in March and April. Dutch exports, although slightly greater than the Belgian, showed the influence of cold *serre* production, arriving, like the Spanish, during the normal harvest period from August to November.

The drastic fall in Belgian grape exports during the early 'thirties is seen in Table 3.[1]

Table 3. *Belgian grape exports* (*in* 1,000 *kgs.*)

1930	2,794
1931	2,909
1932	1,597
1933	1,842
1934	1,657
1935	1,749

Although figures are not yet available, the acreage and production of grapes in Belgium seems to have been well maintained during the German occupation.

THE 1945 ERUPTION OF RUAPEHU

C. A. COTTON

THE VOLCANO Ruapehu, the 9000-foot central and highest peak of the North Island of New Zealand, has long been dormant, but the presence in the summit crater of a lake which, though surrounded by walls of glacier ice, remained warm and occasionally even emitted a little steam, has been recognized as an indication that it was not extinct. It is a member of a group which includes Tongariro and Ngauruhoe,[2] both of which manifest some activity from time to time.

Early in 1945 Ruapehu began to steam. Activity increased, and reached a maximum of intensity in the latter half of the year. From March 1945 to January 1946, the eruption passed through five phases of activity: a steaming phase, a tholoid phase, a lava phase, an ash phase, and finally a solfataric phase.

The steaming and tholoid phases

In the early days of the eruption the crater lake, 600 yards in diameter, was unchanged from its former condition except that the water was warmer than

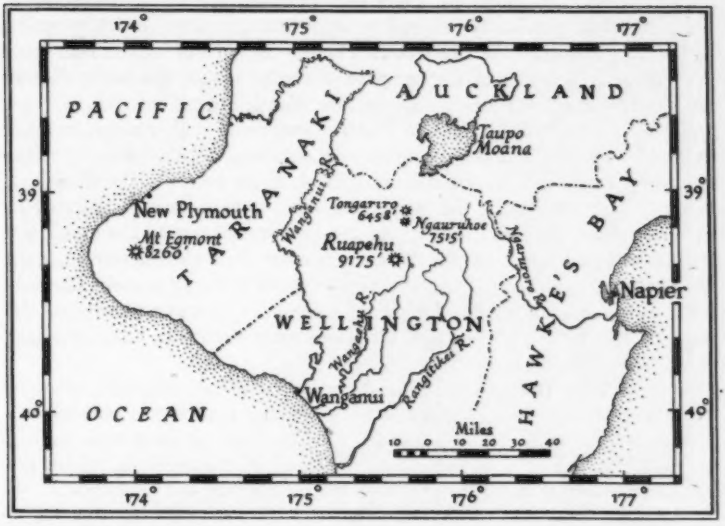
[1] 'Encyclopédie agricole belge,' Vol. 1, p. 812.

[2] C. A. Cotton, 'Volcanoes as Landscape Forms,' Christchurch, 1944, Fig. 118, p. 232.

1. Ruapehu, steaming phase: view from north-we

Phots. R.N.Z.A.F.

usual. Early in March however voluminous steam was belched up through it, escaping apparently from an orifice in the lake floor, and not all evolving by rapid boiling of the lake water (Plate 1). Later some rock fragments also were projected upward to fall back in the lake; and on March 19 an island appeared (Plate 2). As seen by the writer from the air on March 20, the island had the appearance of being a lava mound, the emergent part of a small tholoid, very similar to that which arose in a crater of the volcano Galunggung (Java) in 1918. Steam was escaping under great pressure through chinks between blocks which were apparently, for the most part, displaced portions of a carapace of chilled lava, though it is possible that at that time some blocks on the surface of the island may have been lifted by it from the old lake floor. No ebullition of the lake water was seen. Solid fragments from the island were



occasionally lifted and scattered by the steam blast. Showers of these fragments were falling in the lake, and occasionally quite large blocks fell on the ice-covered rim of the crater.

Only a little dust was carried up by the steam that escaped in this early stage of the eruption, but ash fell in quantity sufficient to discolour the glaciers on the mountain, especially on the eastern side since the wind was prevailing from a westerly quarter. There was some ash on the névé east of the crater even before the end of January 1945, and a premonitory minor eruption occurred late in 1944.

The lava and ash phases

The preliminary stages of the eruption came to an end with the disappearance of the emergent summit of the tholoid, probably as the result of an explosion which was seen by distant observers on March 26. Emission of steam continued however and about six weeks later a new island arose at the

2. *Ruapehu, tholoid phase: view from north-east*

same spot. At first the new island tholoid increased gradually in area, but from the middle of May onwards the lava composing it spread out quite rapidly until, at the end of June, it occupied nearly the whole basin of the former lake (Plate 3). This may be called the lava phase of the eruption. Violent outbursts of dust-laden gases had by this time become of frequent occurrence, initiating the ash phase, which continued until November. Movement of lava on the surface ceased, probably before the end of July.

At the culmination of the eruption in August, the clouds of steam and dust then violently projected upward (Plate 4) were emitted from an inner crater of small dimensions blasted through the body of lava, which by that time occupied the whole floor of the old crater. The orifice became funnel-shaped as a rim of ejected fragmentary material was built up round it.

The lava, exuded in the old crater lake, emerged first as the dome-shaped mass or tholoid previously referred to, and then spread out laterally until it had entirely displaced the lake water. Though the glow of intense heat could be seen through chinks in the carapace of cooled blocks, the water did not boil violently away at contact with the lava island; instead the marginal lava of the tholoid was quickly chilled. The lake water was neither evaporated nor explosively ejected, but was progressively displaced by the lava. The lake level was controlled by a subterranean spillway at the source of the Wangaehu river, the saline nature of the Wangaehu water always having indicated its derivation from the actual crater. As the lava spread out in the crater and expelled the water from the lake basin, observers from the air saw a torrent of hot water spouting from the outlet of the natural spillway tunnel. The outflow ceased suddenly when the intake of the spillway became blocked by the lava.[1] By that time however there was little water left in the basin: the lake had not been deep.

No lava stream emerged on to the outer slopes of the mountain, as might have occurred had the old crater been of smaller capacity or had its wall been breached. At one time it seemed possible that the south-east wall of the basin would give way, just above the head of the ravine in which the Wangaehu river has its source, for here the wall is thin and looks frail.

The solfataric phase

By December the eruption had entered on a decadent, or solfataric, phase, and in January 1946 large pools of water had appeared in the deeper hollows of the lava-filled crater-like basin. There was a crescentic lakelet on a remnant of the old lake floor between the lava front and an old ice wall, and there was also a circular lake on the site of the more northerly of twin vents through the new lava. Vigorous geyser action is now reported in the southern (probably the main) vent. It has developed as ground water has come into contact with the still hot rocks in the volcanic throat.[2] If cooling of the throat continues, this vent will soon contain a deep lake.

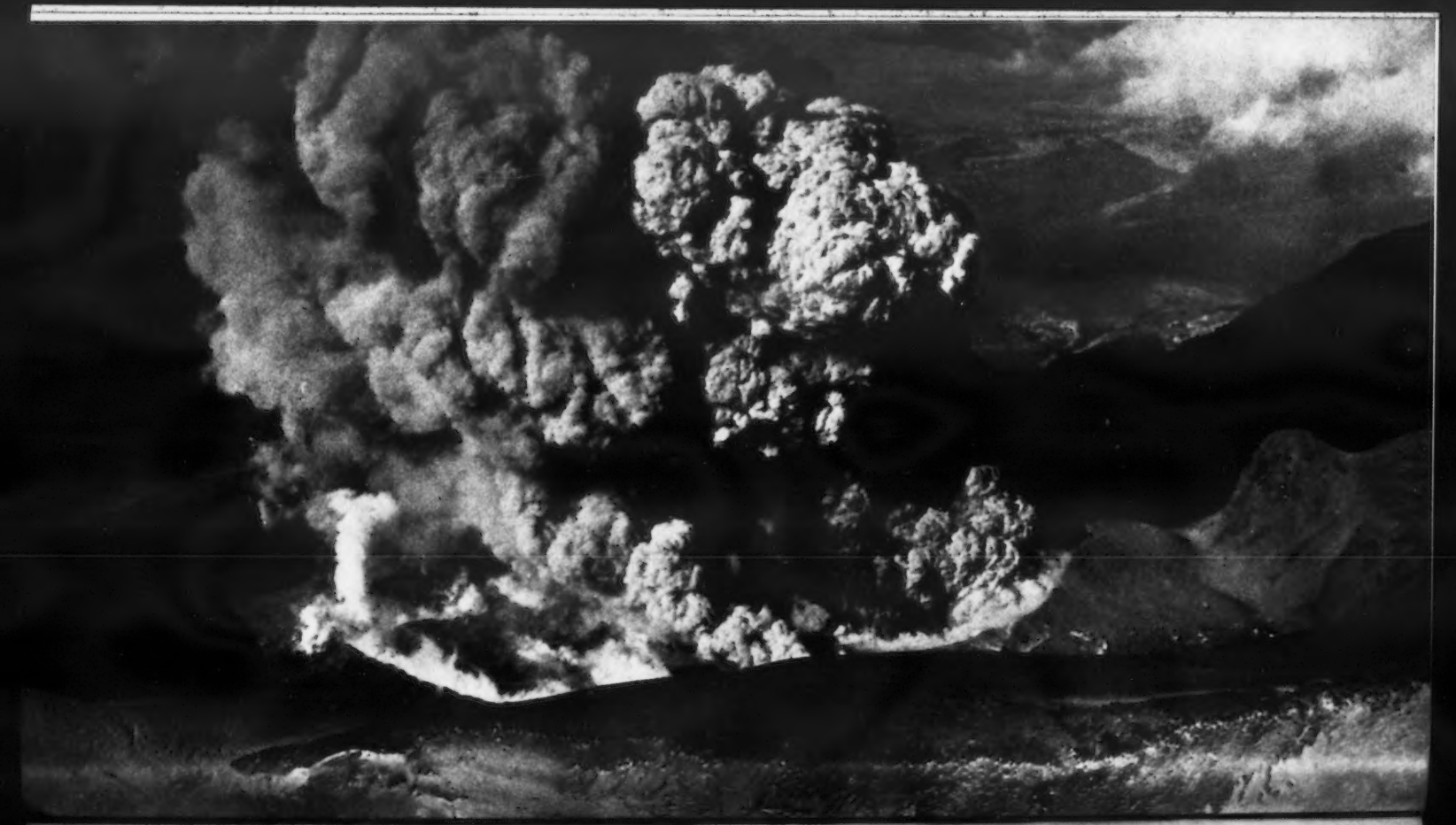
The Ruapehu ash

The product of the eruption was largely a fine ash. This covered the névé fields on the summit so thickly that they not only appeared black but also

[1] My informant is Mr. A. M. Prichard, of the Aerodromes Branch of the N.Z. Public Works Department, who flew over the mountain at a low level on several occasions.

[2] Information from Mr. M. Ongley, Director, N.Z. Geol. Survey.

3. Ruapehu, lava phase: view from south-west



developed a pattern of close-set ravines in typical concentric patterns, which became visible from viewpoints ten to twenty miles away. Even within the old crater fine ash predominated to such an extent that all the new slopes are now deeply furrowed by dissecting ravines. The ash which has fallen on the glaciers and snowfields will not be a permanent contribution to the bulk of the volcanic mountain: much of it has already been washed away by melt-water streams.

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A NOTABLE DESCRIPTION OF RUSSIA

The following extract from Giles Fletcher's 'Of the Russe Commonwealth' is taken from the 'Principal Navigations' of Richard Hakluyt (1599, *vol.* 1, *pp.* 475–6). *It is the first of a series of extracts from the historical literature of geography which we propose to publish from time to time.*

THE WHOLE COUNTREY differeth very much from it selfe, by reason of the yeere: so that a man would marveile to see the great alteration and difference betwixt the Winter, and the Summer Russia. The whole Countrey in the Winter lieth under snow, which falleth continually, and is sometime of a yard or two thicke, but greater towards the North. The Rivers and other waters are all frosen up a yard or more thicke, how swift or broade so ever they bee. And this continueth commonly five moneths, viz. from the beginning of November till towards the ende of March, what time the snow beginneth to melt. So that it would breede a frost in a man to looke abroad at that time, and see the Winter face of that Countrey. The sharpenesse of the aire you may judge of by this: for that water dropped downe or cast up into the aire congealeth into yce before it come to the ground. In the extremitie of Winter, if you holde a pewter dish or pot in your hand, or any other mettall (except in some chamber where their warme stoaves bee) your fingers will friese fast unto it, and drawe off the skinne at the parting. When you passe out of a warme roome into a colde, you shall sensibly feele your breath to waxe starke, and even stifeling with the colde, as you drawe it in and out. Divers not onely that travell abroad, but in the very markets, and streetes of their Townes, are mortally pinched and killed withall: so that you shall see many drop downe in the streetes; many travellers brought into the Townes sitting dead and stiffe in their Sleds. Divers lose their noses, the tips of their eares, and the bals of their cheekes, their toes, feete, &c. Many times (when the Winter is very hard and extreeme) the beares and woolfes issue by troupes out

Ruapehu, ash phase: view from north-west

of the woods driven by hunger, and enter the villages, tearing and ravening all they can finde: so that the inhabitants are faine to flie for safegard of their lives. And yet in the Sommer time you shal see such a new hiew and face of a Countrey, the woods (for the most part which are all of firre and birch) so fresh and so sweete, the pastures and medowes so greene and well growen, (and that upon the sudden) such varietie of flowers, such noyse of birdes (specially of Nightingales, that seeme to be more lowde and of a more variable note then in other Countreys) that a man shall not lightly travell in a more pleasant Countrey.

And this fresh and speedy growth of the Spring there seemeth to proceede from the benefite of the snow: which all the Winter time being spread over the whole Countrey as a white robe, and keeping it warme from the rigour of the frost, in the Spring time (when the Sunne waxeth warme, and dissolveth it into water) doeth so throughly drench and soake the ground, that is somewhat of a sleight and sandie mould, and then shineth so hotely upon it againe, that it draweth the hearbes and plants foorth in great plentie and varietie, in a very short time. As the Winter exceedeth in colde, so the Sommer inclineth to over much heat, specially in the moneths of June, July and August, being much warmer than the Sommer aire in England.

THE GEOLOGY OF FRENCH EQUATORIAL AFRICA

ESQUISSE GÉOLOGIQUE DE L'AFRIQUE ÉQUATORIALE FRANçaise. Notice explicative de la carte géologique provisoire de l'A. É. F. au 1/3,500,000. By P. LEGOUX and V. HOURCQ. Bulletin du Service des Mines, No. 1, Gouvernement Général de l'Afrique Équatoriale Française, Afrique Française Libre. *Cairo: Imprimerie de l'Institut Français d'Archaéologie Orientale*, 1942. 11×8½ *inches;* xxii+96 *pages.* (*Map. Cairo: Service Géographique des Forces Française Libres au Levant*, 1942.)

THIS PUBLICATION and the accompanying map, produced under war conditions, reached the Society in 1944. A somewhat similar publication on French West Africa was reviewed in the *Journal* some months ago (vol. 105 (1945) 129–33), and the present review is a sequel to it.

It should be stressed that the work for both Bulletins had been the result of many years' labour by a large number of geologists in Africa, and that the synthetic process was reaching a fruitful stage in the years immediately before the war. The meetings of African geologists at the International Geological Congresses, the active work pushed forward between the congresses, the preparation of the African sheets of the International Geological Map, the splendid pioneer work of M. Blondel in connection with all these, and the meetings of geologists in Africa, as at Kigoma some years ago: these and many other efforts were symptomatic of a new stage in African geology. Within the region of the present Bulletin, the long list of geologists given on the map shows how widespread and sustained the effort has been, and yet, as M. Legoux remarks in

acknowledging previous work, the Bulletin emphasizes the incomplete state even of reconnaissance survey.

This is not surprising because French Equatorial Africa occupies more than 28° of latitude and 19° of longitude, a little less than an eighth of the area of Africa, in which all the geographical regions assume vast proportions and any one of them may be the size of France. Moreover the contrasts between them are as impressive as their size, from desert to equatorial forest, and from geological attributes allied to those of the Sahara, West Africa, Libya, Egypt, and the Sudan, to those of South Africa, the Congo, and East Africa. The region is a geological bridge between northern and southern Africa about which much is still to be learned, and its mapping demands a multiplicity of symbols, some for the north, others for the south, among which coordination is not yet complete. To analyse such a synthesis is a formidable task: in attempting it the reviewer will draw analogies with other parts of Africa.

Generally speaking, the crystalline and metamorphic rocks may be taken to represent the Archaean and Algonkian respectively, but rarely is the latter seen to be discordant on the former. More often they present a generalized granito-gneissic complex, metamorphosed eruptive and sedimentary rocks, ortho- and para-gneisses and schists. The distinction is frequently purely petrological and some confusion is inevitable at present: thus the Algonkian metamorphic rocks of the Muva-Ankole System, gneisses derived from intrusive granitic rocks, and migmatites resulting from an intimate mixture of such rocks are included: so are later granites about which lack of information denies any other identification. The problems are those of the Basement Complex and associated metamorphic rocks in any part of the world. On the map, colours and symbols are used to define Granito-gneiss, older Algonkian, of petrological types, according to the available evidence. An upper Algonkian group is distinguished, but these divisions of the Algonkian are tentative. Some of the main regions are described and their problems can be followed in surrounding British, Belgian, and other territories. There is much valuable information supported by a considerable literature, but further description will serve no useful purpose here.

Perhaps the most difficult stratigraphical problems north of the equator and south of the Atlas lie in the Ancient Sedimentary Series and the next division (continental Palaeozoic and Mesozoic formations). There are two provinces: (1) Equatoria and the Congo basin, allied to Katanga, Rhodesia, Angola, and the south; (2) the Chad basin with Nubia, Libya, southern Algeria, and French West Africa. Correlations between the two provinces present special problems with limited prospects of solution. The Bulletin is more particularly concerned with relationships within the first-named province.

In French territory, *i.e.* Equatoria and the margin of the Congo Basin, there are two ancient sedimentary series, the Schisto-calcaire and the Schisto-gréseuse. They occupy a syncline which passes southward into a synclinorium (Niari synclinal): the structure runs parallel with the Atlantic coast and forms the chain of the Congolides (of Krenkel's analysis) until it disappears under younger beds in Angola. Several geologists have worked out a stratigraphical sequence in this exceptionally difficult tropical belt. The Schisto-calcaire consists of a basal conglomerate which is believed to be a tillite, that is, of glacial origin, probably continental and not marine, followed by a long succession of dolomites and limestones, some recrystallized and others highly silicified, which are well known in the Katanga region. Some of them, particularly those high in the sequence, contain bodies identified as marine algae and problematical forms known in analogous rocks in Tanganyika, Katanga, and Mauritania.

The overlying Schisto-gréseuse beds consist of a long series of argillaceous

and arenaceous sediments with coarse sandstones and a conglomerate in the upper part, associated with cross-bedding and reddish coloration: general opinion considers their origin to be arid and continental. The series is evidently unconformable on the Schisto-calcaire: during the recession of the sea which formed the older group considerable erosion took place, and it is thought that the main folding of the Congolides took place before the Schisto-gréseuse series was laid down. The latter were subjected only to a later phase of the movements.

Several other series of considerable local importance are probably more or less analogous to those described above. There is lithological and sedimentary homogeneity of the Schisto-calcaire and Schisto-gréseuse from Angola northward to the latitude of Stanley Pool, and it is suggested that the various patches farther north represent facies, with some individuality, of the general succession. If this view is tenable it will help to compose the numerous and diverse opinions expressed by many authors. African geologists will note that the Fouroumbala series is associated in the Bulletin with the Schisto-gréseuse rocks and the Ogoué system is thought to be a Gabon facies of the Schisto-calcaire and Schisto-gréseuse: space forbids a fuller review of these matters.

So far as general correlation is concerned a scheme was adopted by the meeting of geologists at Kigoma in 1931 which in general has stood the test of time rather well, and it is regarded as a standard for reference. At that meeting a Katanga system was proposed, to embrace such groups of sediments as have been mentioned above. But trouble begins when attempts are made to pursue similarities, and some lively controversies have arisen on this score. Latterly however several geologists have agreed on a correlation whereby the divisions of the Congo Basin and adjacent French territories can be brought into line with those of Katanga and Rhodesia (Système schisto-gréseux = Upper Kundelungu, Système schisto-calcaire = Lower Kundelungu, basal conglomerate = Katanga tillite or Grand Conglomérat). There are ramifying paths in this jungle of nomenclature along which none but geologists need tread: the text of the Bulletin seems to follow a skilful and sound route, with the suggestion that the characteristic geosynclinal succession is fully represented in the Congolides whereas in the interior only the upper beds occur. Suggestions are made, which had been put forward at Kigoma, as to the relationship of the various rock groups to the Transvaal and Waterberg systems of South Africa. Finally it is proposed that the Schisto-calcaire may be of Upper Algonkian age and the overlying beds older Palaeozoic, but evidence of age is extremely scanty. It will be realized that much of the foregoing rests on the geology of regions outside French territory, and that some of the problems may in fact be insoluble.

In the Chad basin the stratigraphy of the sediments that lie on the Basement Complex is fairly straightforward, and one is impressed by the vast scale of simple geological processes which made a single province of most of northern and western Africa. Here, then, there is continuity, and analogies may be drawn from remarks in the previous review (*Geogr. J.* 105 (1945) 129–33). The rocks are dominantly sandstones and are prominent in the great massifs of Tibesti and Erdi-Ennedi; they occur also in Ouadai and on the western border of the Anglo-Egyptian Sudan, for example Massalit. West of Tibesti they may be followed to the Ahaggar, and northward from Erdi into Libya and south-western Egypt. Here and there they contain algae which are known chiefly from Lower Palaeozoic marine sediments in several parts of Europe and North and South America, as well as in other parts of Africa. In the Ahaggar some of them pass into graptolite shales: probably they are mainly (but not exclusively) of marine shallow water facies in the west, and of continental origin in the east. They need

no further description here, and there is a considerable literature dealing with them.

Continental deposits of Palaeozoic and Mesozoic systems follow the largely marine sediments already described. Once more they fall into two geographical groups, roughly north and south of the equator, and as yet they can be correlated only in a very general way. In the Congo basin these non-marine beds form the Lualaba-Lubilash system (Congo system of Krenkel). At the base is a glacial tillite attributed to the Dwyka of southern Africa, succeeded by beds with the *Glossopteris* flora: these two form the Lukuga stage (Permian). The Lualaba beds (Trias) follow, argillaceous in the east and arenaceous in the west, with fish remains. The succession is completed by sandy beds (Lubilash or Sankuru). The Kigoma meeting agreed that beds up to and including the Lualaba are equivalent of the Karroo system of southern and eastern Africa. The upper beds are therefore either post-Karroo or an undetermined part of it. Veatch drew closer parallels with the Karroo, regarding the Lubilash as also of Triassic age and the tillites as Upper Carboniferous. On the whole his analysis of the Karroo itself and of its occurrences in the Congo basin is useful and convincing. In general the beds form a broad rim round the basin and underlie the alluvial deposits of the more central part.

There are three main areas of these rocks in French territory, but they represent only the Sankuru (Lubilash) and perhaps a part of the western, sandy, facies of the Lualaba, but there are no fossils to settle the question. The beds are often cross-bedded and evidently of continental origin, and in all three areas rest directly on the crystalline and metamorphic rocks: in and around the Congo basin they cover the ancient sediments (Kundelungu). In one of the areas (Batékés plateau, north-east of Brazzaville) the sandstones have given rise to unstratified masses of sand as much as 100 metres thick: much silicification has also taken place. The silicification may be due to superficial metasomatism related to the present topography; or it may have arisen locally from lacustrine formations developed on the surface of the sandstones after their deposition and under arid climatic conditions, the beds now being laid bare by erosion. These silicified rocks are sometimes known as the polymorphic sandstones. The problem which they present is made more difficult by the discovery at Kounzoulou, 100 kilometres upstream from Brazzaville, of similar rocks containing freshwater fossils, some of them recalling Tertiary forms. Silicification and the presence of non-marine fossils are in fact problems not only here but in Rhodesia, the Kalahari, and Angola: various authors have assigned ages ranging from the Jurassic to the Oligocene. The best policy for the moment, which is advocated in the Bulletin, seems to be the distinction of the Kounzoulou beds, analogous occurrences at Mont Bunza on the Sudan–Congo border, and some others from the Lubilash. Other sandstones which have proved difficult in the past are those of Ouadda, on the R. Kotto and of Carnot (Upper Sangha basin), but they seem to fall naturally into the Lubilash–Karroo association and to be related to sediments in the Congo basin rather than to those of northern Africa.

In the great arid regions of the Chad basin, of the Sahara and all adjacent territories, including the Nile basin, a special problem is set by beds grouped together as the Nubian Sandstone, a term which, as the reviewer pointed out some years ago, is not only loose but unfortunate. French geologists, especially Kilian, are of the same opinion, and the position is accepted and interpreted in the Bulletin in the spirit of those views. The term is used therefore in a broad sense, to define post-Tassilien continental sandstones, divisible locally into a Palaeozoic series (the Continental post-Tassilien of Kilian) and a probably

Mesozoic group (Nubian sandstone, *sensu stricto*); the latter, within working limits, is Kilian's Continental intercalaire and the Nubian series of the reviewer.

Kilian's Continental post-Tassilien ranges from Middle, possibly Lower, Devonian to the Middle Carboniferous. Fossil plants have been found in the sandstones: one group is lowermost Dinantian (Tibesti, Bardai), another is Upper Culm (Murdi region, Kufara, 'Uweinat). These beds are replaced west of lat. 11° E. by marine sediments. The Continental intercalaire, as defined by Kilian, is a sandy series with interbedded marls, younger than the Continental Westphalian beds of the Taoudeni syncline (see *Geogr. J.* 105 (1945) 129–33), older than the beds of the Cenomanian transgression, and attributed to the Jurassic and Cretaceous on the hypothesis of a big post-Carboniferous gap in the sequence. The beds are widely represented in southern Algeria and the arid regions of the French Soudan and Niger. The reviewer has defined and subdivided analogous beds in the northern part of the Chad basin and southern Libya, southern Egypt and the northern Sudan, and before the war Desio was doing similar work on the continental beds as a whole in Libya. They are considered to be of continental origin in these regions, although Shukri has recently demonstrated a marine origin in the north-eastern part of the Egyptian zone, and such may well be the case there for various reasons.

The Nubian beds occur substantially from the Chad basin to the Mediterranean and from the Atlantic to the Red Sea, and they play an essential part in the water supply of a high proportion of that vast area: their nature and origin and stratigraphy are of geographical importance as well as of geological interest, and space alone prevents a fuller treatment of them in this review and that published in an earlier *Journal*.

In the Bulletin an analogy is drawn between them and some Jurassic-Cretaceous sediments with fossil plants, fish and saurian remains in the Upper Bénoué, about 250 miles south of Fort Lamy: similar beds are probably present elsewhere in the Bénoué basin and the Cameroons.

The association of the Nubian Series, the Lubilash, and the upper part of the Karroo, suggested by the reviewer some years ago, seems to find some acceptance. Such analogies rest mainly on peculiar facies, the presence of fossil wood (*e.g. Dadoxylon* in the Nubian Series, Continental intercalaire, and the Karroo of Rhodesia and South Africa), and on the general palaeogeographical development of the continent. Precise contemporaneity, even in the geological sense, cannot be effectively considered owing to the present lack of diagnostic fossils. It will be noticed that the earlier glacial phases, so marked a feature of southern and equatorial Africa, find no counterpart in the north.

Transgressive, epi-continental, fossiliferous, marine Cenomanian and other Cretaceous beds, so widespread in northern and western Africa, seem to be represented in French Equatorial Africa only in the Bénoué, with outliers near the western margin of the Chad basin. There was, doubtless, a considerable transgression from the west toward Tibesti and the continental watershed, but little remains, or is exposed, to-day. Marine Cretaceous beds are well developed on the coast of the Cameroons. Marine Tertiary beds, developed in the Bénoué, Nigeria, and the Niger basin, scarcely enter French Equatorial Africa, and continental Tertiary beds are poorly developed in the interior. The Bulletin includes some brief notes on the heterogeneous Tertiary to Recent river gravels, alluvium, aeolian, and other sands, laterite, diatomaceous earths, and other superficial deposits: each of these is a subject in itself, which, with few exceptions, awaits thorough investigation. A general account is also given of the Recent, or perhaps Tertiary to Recent, volcanic rocks and volcanoes of the great north-east–south-west Cameroon fracture (Mount Cameroon being

still active), of Oudai, and of the majestic mass of Tibesti. The rocks in many of the volcanic areas are generally basaltic, but in Tibesti basalts seem to have antedated and postdated an exceptionally interesting succession of trachytes, phonolites, and rhyolites, and great calderas point to violent phases in the volcanic history of the region. The Mission au Tibesti was noticed in the *Journal* some years ago (vol. 87 (1936) 80, and vol. 88 (1936) 177).

The final part of the Bulletin, by Victor Hourcq, is based primarily on the work of the Syndicat d'Études et de Recherches pétrolières in the coastal belt. Results are still provisional, but already indicate important exploration of two embayments of fossiliferous marine Cretaceous sediments, one from Libreville southward to Mayoumba, the other around Pointe Noire. The former may be followed northward and suggests comparisons with the coastal geology of Nigeria; the latter may be traced southward into Angola.

It is evident therefore that the geology of the Atlantic coast is fast entering a new and detailed stage, based on palaeontological as well as stratigraphical evidence. Comparisons are made in the Bulletin to cover the great length of coast, and, despite contrasts which are already indicated, there is a general basis of uniformity. The outstanding facts seem to be that in the Libreville district the Cretaceous is fairly complete from the Neocomian to the lower part of the Senonian, discordant on the Schisto-greséux, with also a pre-Cenomanian discordance; farther south, rock salt is developed at the base, on the ancient crystalline rocks, succeeded by Albian to Danian sediments. Around Pointe Noire the succession evidently is rather fragmentary. Several transgressive and regressive phases can be detected. Tertiary beds seem to be lacking, and the sequence is completed by Plio-Pleistocene to Recent beds, and some basic volcanic rocks. The day may not be far off when a detailed history of the whole Atlantic seaboard of Africa may be achieved, possibly by means of the commission of the International Geological Union.

There is much that cannot be discussed in this review for reasons of space. The Bulletin itself is a useful document: the accompanying geological map has inset a structural plan and a long list of authors and organizations whose work over many years has gone into its compilation. Jointly, Bulletin and map carry on the work of the 'Altas des Colonies françaises,' published a little more than ten years ago.

K. S. SANDFORD.

REVIEWS

EUROPE

THE NEW EUROPE: an introduction to its political geography. By WALTER FITZGERALD. *London: Methuen*, 1945. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* ix+25 *pages; maps.* 14*s*

It is perhaps significant that in recent years few studies on the problems of European boundaries have appeared in this country. This is probably due to a sense of uncertainty as to the principles ultimately to be adopted for their delimitation. If power politics working, for example, through enforced mass migrations were to prevail, the detailed examination of existing boundaries, with suggestions for their improvement, would clearly be wasted effort. Professor Fitzgerald sets out to combat the idea that conditions of human geography can be treated in an arbitrary manner in establishing a permanent and workable European system. For him, boundaries are at the best unfortunate necessities, "artificial lines of division which obstruct inter-regional cooperation, their purpose being to partition what to nature is indivisible"; the importance currently attached to them derives from the conception of the national state and its corollary, self-determination. Geographical and historical conditions favoured the growth of this idea in France and Britain, but in his view it is impracticable to apply it absolutely to Central and Eastern Europe. He looks therefore to some limitation of national sovereignty, perhaps on the lines of the Soviet federation, with the application of modern geographical technique to adjust boundaries to the complex of geographical and human factors.

After defining his own concept of political geography, Professor Fitzgerald deals with each country separately with the main emphasis on boundaries, languages, and religions. As these sections do not cover the full scope of his definition of political geography, the reader receives the impression that this book is perhaps a part only of a more extensive study. But within these narrower limits it contains a great deal of clearly arranged material against a consistent geographical background. It is perhaps understandable that much of it is critical of the settlements of 1919; yet these were genuine attempts to apply a principle, and in so far as they failed, the failure was due to wider causes. It is clear that the prospect of some form of European federation involves far more intractable issues than in the case of the Soviet federation, which was largely imposed from above. The extensive bibliographies which follow the chapters are useful, though there are a few omissions and some repetition. G. R. C.

ASIA

CHINA AMONG THE POWERS. By D. N. ROWE. (Institute of International Studies, Yale University.) *New York: Harcourt Brace*, 1945. 8×5 *inches;* x+206 *pages; sketch-maps.* $2.00.

This book sets out to examine whether China's position as one of the Big Four is based upon actual or potential military power comparable with that of the British Empire, the U.S.S.R., or the U.S.A. Mr. Rowe's study is well documented and temperate in tone, and he cites Chinese authorities whenever possible. The book is divided into four parts: China's world position to-day; China's resources for military power; integrating China's power; and China in the world of to-morrow.

In the first part the author shows that China's long war of resistance "depended vitally in the first instance on the Japanese error of underestimating China's power to resist." He shows further that Chiang Kai-Shek relied upon the Japanese making this mistake, just as he relied on the fact that Japan would inevitably quarrel sooner or later with the western powers. A parallel may be drawn with British policy in 1940, when we looked to the equally certain impending breach between Germany and Russia. China proved strong in defence partly because she was industrially under-developed. The absence of modern communications made a Japanese advance into the interior very difficult, just as it made a Chinese counter-offensive impossible.

In part two Mr. Rowe shows that China's resources of the basic materials of modern industry and military power are not as great as has often been supposed. The main deposits of coal are far from the sea or from navigable rivers. Oil has been found only in the remote north-west. The aggregate known reserves of all the primary industrial raw materials are far smaller than those of the U.S.A. or of Europe. From these facts the author concludes that China is not likely to be able to maintain the armaments of a first-class military power. This part of his argument has been to some extent superseded by the arrival of the atomic bomb, and the possibility of the future development of atomic power for industrial purposes.

In part three Mr. Rowe discusses the influence of China's political problems on the growth of modern industry and military power. Here he has much to say that needs emphasis. Of the tendency to represent the issue between the Chinese Communist Party and the Kuomintang as a struggle between "democratic" and "Fascist" elements, Mr. Rowe remarks, "this is only another example of the unwisdom of indiscriminately applying to the analysis of Chinese problems the preconceived categories derived from the study of western society." In an interesting chapter on Government and social organization, the author discusses the traditional vices and virtues of the Chinese political system. He points out that these virtues—reliance on culture rather than on military power as an integrating force, individualism, and the spirit of pragmatism—became sources of weakness in an age of "sudden social earthquake." Answering criticisms of Chiang Kai-Shek's many shifts of policy, he reminds us that "those who urge the Chinese to lift the level of their political morality should remember that without survival there could be no morality."

The greatest problem before the Chinese is the rapid growth of population. Mr. Rowe points out that every advance in public health and scientific knowledge will accelerate this growth. Cheap labour due to over supply makes it difficult to train a large body of skilled workers. Low wages force down health standards and militate against efficiency. For these reasons the industrialization of China will be a long process dependent upon foreign capital, for Mr. Rowe holds that China cannot imitate Russia and effect rapid industrialization by reducing the standard of living. Margins in China are too small, and the individualistic Chinese would not tolerate the totalitarian regime which would be needed to carry out a policy based on the Russian example. C. P. F.

PIONEER SETTLEMENT IN THE ASIATIC TROPICS: studies in land utilization and agricultural colonization in south-eastern Asia. By KARL J. PELZER. (Amer. Geogr. Soc. Spec. Publn. No. 29). *New York: American Geographical Society*, 1945. $10 \times 6\frac{1}{2}$ *inches; xviii+290 pages; illustrations and maps.* $5

For many years Dr. Pelzer has been deeply interested in pioneering, especially in the tropics. The 1939–45 war curtailed considerably his projected travels

through Asia, but in 1940–41 he was able to visit the Philippines and the Netherland East-Indies, and it is therefore mainly with these territories that his book is concerned. The war has since rolled through the whole of this area, and changes have been made which may vitiate some of the conclusions reached: one of these is the acceleration of previously existing nationalist movements in Java and elsewhere; another the creation of boom demands for certain crops in areas which lay outside the range of a "scorched earth" policy. But the fundamental problem, which remains crucial, is the maladjustment of population distribution throughout south-eastern Asia. Especially acute in Java and Madura, it is hardly less serious in French Indo-China. In the Philippines, population pressure is rather a matter of local over-concentration, which could be relieved by planned migration to less populous islands within the group.

The first three chapters of the book are a background study of the many types of agriculture represented in south-eastern Asia. At one end of the scale there are people still in the food-gathering and hunting stage; at the other, sedentary cultivators capable of using irrigation water with skill, and of constructing elaborate terraces on steep hill-sides. A conflict of interest naturally arises between the shifting cultivator and the sedentary farmer, and under tense population pressure it is the settled community which is likely to be favoured.

The rise in the population of Java from twenty millions in 1880 to nearly fifty millions to-day presents a major problem. The density is 800 per square mile or, more significantly, 1300 per square mile of cultivated land. Even this figure gives only an imperfect impression of the close occupation, for there are several thousand people per square mile of irrigated land. Conditions in Java can be compared only with those in the overcrowded delta-lands of China, India, and other parts of the Monsoon fringes. Not far from such overcrowded areas there are underpeopled lands available for development, such as Sumatra, Netherlands Borneo, and other parts of the Outer Islands of the Netherlands East Indies.

Dr. Pelzer draws two contrasting pictures. In the more closely settled parts of the Philippines, children are encouraged to look forward to a happy future as pioneers in the "frontier island" of Mindanao, on which Japan has cast longing eyes. In Java, on the other hand, the intending emigrant is almost a pariah in the eyes of his neighbours, largely because the authorities have in the past encouraged some of the less desirable to depart. Bitter experience of failure has given rise to the more recent policy of selecting potential migrants; even so the undesirable migrant has not been entirely eliminated.

Experience generally has led to the view that migration must be controlled by government agencies, and cannot develop successfully of its own accord, though qualities of initiative must be shown by the colonists. Dr. R. L. Pendleton, in a review-article dealing with Dr. Pelzer's book (*Pacific Affairs* 19 (1946) 101–108), argues that governments are seldom justified in establishing formal colonization schemes but should rather provide the opportunities for successful migration by constructing highways, dividing the settlement area into farms of suitable size, and providing medical, educational, and police services. Dr. Pelzer maintains that the population problem can be solved by a combination of planned migration with industrialization in the rural areas themselves though his book has few references to towns as industrial or even market centres. It is however difficult to see how the standard of living is to be raised sufficiently to support industrial and trading communities, unless each farmer's holding be so enlarged that he can grow a cash crop as well as his own foodstuffs. Nor is it possible to foresee how the withdrawal, however partial, of American and Dutch interests will effect the economic life of the islands.

Dr. Pelzer's book will be of absorbing interest to all who are concerned with the problems of migration, with tropical agriculture, or with the regional geography of south-east Asia. One hopes that he will soon be able to complete the field studies he has already planned. If the geographical approach, so admirably illustrated in this book, could be extended to the administration in all colonial territories, these vital problems might be brought into clearer focus.

T. W. F.

MALAYA: outline of a colony. By VICTOR PURCELL. *London: Nelson*, 1946. 7×5 *inches;* 145 *pages ; illustrations, maps, and diagrams.* 6*s*

Victor Purcell's new book is, despite its size, the most informed survey of Malayan affairs to have appeared in recent years. The author brings to his study long years of association with Malaya from the inside, and of direct experience in administering its complexities. After the first few chapters, in which it is evident that he is finding difficulty in presenting his subject to those to whom it is entirely new, Purcell writes with the ease and restraint of one who is completely at home with his material. This book might well be cited as an indictment of that official ban which prevents civil servants from writing about their specialized studies; a ban which must be held responsible for much ignorance of conditions in those territories for which we are politically responsible.

Purcell's 'Malaya' deserves the widest reading among those British people who are still inclined to be critical of the Malayan campaign of 1941. It was inconceivable that Malaya, with a population half that of London, could have withstood the full weight of the Japanese attack, least of all at a time when Britain was mortally exposed by the collapse of France and had taken the grim decision to concentrate all available military forces in North Africa. As Purcell says, "The verdict of history may be that this decision was one of the most courageous and statesmanlike that have ever been taken in any crisis." Unfortunately this will be no consolation to those who had done much to make Malaya what it was.

It is a pity however that the book has been so long delayed in publication. This is the book which we should have had at hand before the British re-entry into Malaya, in preparation for the new political and social problems we were likely to find there. At the present time, the book will be a disappointment to those who come to it for practical guidance on Malayan affairs. It would seem too that the author has an over-scrupulous regard for his official impediment. The book offers merely background and a statement of Malayan problems, with no positive and constructive suggestions as to how those problems might be solved by administrators with his own humanitarian approach, informed background, and administrative ability.

E. H. G. D.

JAPAN: a physical, cultural and regional geography. By GLENN THOMAS TREWARTHA. *University of Wisconsin Press*, 1945. 9½×7 *inches;* xv+607 *pages; maps, diagrams, and illustrations.* $5.00

Professor Trewartha's earlier work, 'A reconnaissance geography of Japan,' gave an account of the country as it was about 1930. The present work is a much fuller account of it ten years later. The intervening decade saw the culmination of the organization of Japan's industries for war, an organization which very considerably altered the industrial geography and life of Japan as well as its relations with its neighbours. The area dealt with is Japan proper, which is almost exactly the territory now left to Japan, excluding all the areas annexed during the period of imperial expansion from 1875 to 1943.

There is a brief introduction on the position of Japan in monsoon Asia. The

body of the book follows in three parts. Part I, a little less than a fifth of the whole, is an account of the physical geography and the natural resources. Most of it is a revised edition of the corresponding parts of the earlier book, but the account of the mineral resources is much fuller. Part II, a little less than two-fifths, treats of the cultural geography of the country as a whole. While Part III, the longest, describes some 136 regional subdivisions of Japan.

Dr. Trewartha begins his study of cultural geography with an account of the man-made features of the Japanese landscape: the paddy fields and the irrigation works associated with them, both on the flat lands and on terraced slopes, the planted and controlled forests and orchards, the houses and their grouping into villages, towns, and cities, the communication ways which link them, the ports and the industrial areas. It is probable that the material for an historical account of this human occupation of the land is not readily accessible to a westerner. It is therefore not surprising that there is little treatment of historical geography. As a method of studying human geography this work should be of special value to those geographers who normally use the historical approach.

The economic geography is very fully treated, with much emphasis on the recent development by the Government of the armament industries. It may be noted that the chief area of these industries, situated on both sides of the narrow Shimonoseki Strait with Yawata as its central town, had by 1939 grown to form a conurbation of more than a million inhabitants. Its two parts are connected by a tunnel under the strait, which was nearing completion in 1940. It was then one of the world's larger centres of the iron-and-steel and armaments industries. Much the greater part of its raw materials were brought by sea from other parts of Japan and from abroad, and few industrial areas can have been so dependent on sea transport. By 1940 the industrialization of Japan had led to the growth of four large conurbations. The confluent cities on the shores of Tokyo Bay formed the third largest in the world, with about eight million inhabitants. The Osaka-Kobe group, with the nearby ancient metropolis of Kyoto, had four million; and Nagoya and Yawata both exceeded a million. Together these four included a fifth of the total population of Japan.

In opening Part III the author writes (p. 341): "The land of Nippon is a mosaic of areas of varying sizes, differing from one another in one or more of the principal physical or cultural elements. Each subdivision has a degree of unity with respect to at least one of the important geographic elements. In some areas the dominant and unifying feature is terrain; in others climate; in still others it may be location or a type of land use." The descriptions of these regions are vivid and often very detailed.

The book is very well illustrated and documented. It would be easier for the student if it had classified indices to its maps and diagrams and tables, as well as the general index. Such an addition is well justified by its importance; for it is, and is likely to remain for many years, the best book on the geography of Japan.

C. B. F.

NORTH AMERICA

THE PURCELL RANGE OF BRITISH COLUMBIA. By J. Monroe Thorington. *New York: American Alpine Club*, 1946. 9×6 *inches;* 152 *pages; illustrations and maps.* $2

"The Purcell Range is a mysterious and complicated sector, exerting upon many climbers a fascination similar to that of the Isle of Skye upon British mountaineers." And in this excellent little volume, Dr. Thorington, an ex-President of the American Alpine Club and editor of its journal, goes far to demonstrate the truth of this dictum.

The Purcell Mountains lie adjacent to and south-east of the better-known Selkirk Mountains, with which they were at one time grouped (as by G. M. Dawson) in one system. It was R. A. Daly who showed that structurally, as well as topographically, the Purcell Range should be treated as an individual entity in this remarkable complex. (Reginald A. Daly, "The nomenclature of the North American cordillera between the 47th and 53rd parallels of latitude," *Geogr. J.* 27 (1906) 586–606.) The author traces the earlier history of this region of high, rocky peaks and deep, heavily forested valleys; and of the fur-traders, gold prospectors, surveyors, and other travellers who sometimes came to settle, but more often passed on. Remote and sparsely populated as this "difficult" country is, it should not be forgotten that at its southern end is situated the rich Sullivan Mine, remarkable for its complex ores of lead, zinc, silver, tin, cadmium, and bismuth, which are treated at the Empire's largest non-ferrous smelter at nearby Trail.

Mountaineering, combined with surveying, can be said to have commenced in 1910, when T. G. Longstaff and A. O. Wheeler, with the Austrian guide Conrad Kain, visited the Bugaboo Valley and occupied ten survey stations between 7000 and 9000 feet, two of the party continuing westward across the range to Duncan Lake (T. G. Longstaff, "Across the Purcell Range of British Columbia," *Geogr. J.* 37 (1911) 589–600). They reported high and sharp rock peaks in the vicinity of their pass and, to the northward, towering summits later named and measured, such as Howser (10,950 feet), Bugaboo Spire and Pigeon Spire (both 10,250 feet), and the Bobbie Burns group (Mount Conrad 10,300 feet). These were not ascended until 1916 and subsequent years by Canadian, American, and British mountaineers, often with the assistance of that outstanding guide and character Conrad Kain, who died in 1934, just before the publication of his book 'Where the clouds can go,' which was edited by Dr. Thorington.

It was not till 1928 that Dr. Thorington, with the devoted assistance of Kain, commenced his own explorations and surveys, particularly in the southern section of the Purcell Range to the headwaters of St. Mary River. Dr. Thorington devoted four seasons to pioneer work in the range, approaching most of the higher peaks through the heavy forests of the difficult eastern valleys. His graphic narrative, frequently enlivened by amusing quotations from the broad philosophy of Kain, and illustrated by a large number of excellent photographs and sketch-maps, makes entertaining reading.

There is need of much further pioneer work and, as the author maintains, a great deal more accurate mapping: not even the precise location of the east–west Kootenay watershed has as yet been fully determined. The Alpine Club of Canada has decided to pitch its annual camp in July 1946 on a site in Bugaboo Creek, whence the northern peaks of this grand range can be further examined from the eastern side. But it is the entire western flank that offers an outstanding opportunity for fresh topographical work as well as first-class mountaineering, in a range that is known to have at least eight summits of over 11,000 feet, and more than fifty which attain 10,000 feet, some of which are still virgin.

N. E. O.

PHYSICAL GEOGRAPHY

THIS WEATHER OF OURS. By ARNOLD B. TINN. *London: George Allen and Unwin*, 1946. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches; 147 pages; illustrations, maps, and diagrams.* 10*s* 6*d*

The author is an enthusiastic weather observer and sets out, in a conversational and occasionally rather superior style, to foster a lively interest in British weather. He quotes freely, both from the official sources and from his own

records, a wealth of phenomenal occurrences of rain, snow, heat, cold, temperature change, winds, storms, tornadoes, thunder, etc., but as a good scientist he is careful to pay due attention to the normal and to keep the exceptional in true perspective. The emphasis throughout is on observation and the recording of facts, and there is little attempt to explain the occurrences in terms of the synoptic situation or of atmospheric structure, the weather map and forecasting being "too great a subject to deal with in this book other than superficially." There are some interesting, short accounts of samples of regional and local climates in a search for "your favourite climate" and a brief consideration of the effects of weather, both out of doors and in, on physical and mental well-being.

Within its quite modest compass 'This weather of ours' provides for the layman a well-balanced general account of the climate of Britain, and in a book so systematically arranged the absence of an index is not a serious omission.

A. A. M.

THE PULSE OF THE EARTH. By J. H. F. UMBGROVE. *The Hague: Martinus Nijhoff*, 1942. $9^1_2 \times 7$ *inches;* xvi+180 *pages; maps and diagrams*

In this work Professor Umbgrove attempts to review the Earth's history and structure in the light of present knowledge. Suess, in 'Das Antlitz der Erde,' at a time when vastly less knowledge was available, required several volumes to deal with the subject; it is obvious therefore that a selection of topics for discussion was necessary, and the aspect of earth history to which attention is specially directed is that of the movement of the crust and its probable underlying cause. After a brief review of the relation of the earth to the solar system and the universe, the author considers mountain chains, basins and troughs, the crust and its substratum, oscillations of sea-levels, the floor of the oceans, ice ages, the rhythm of life, and the pulse of the earth.

The general theme underlying the treatment is that movements of the earth's crust show evidence of periodicity which, it is claimed, also operated during the Ice Ages of the past. This explains the choice of 'The pulse of the earth' as the title of the book. When one realizes how irregular is the rhythm of earth movements one wonders whether the simile is entirely apposite. Detailed evidence of movements during the main periods of compression is reviewed in an appendix of notes and coloured plates in which four epochs are recognized, viz. Caledonian, Variscan, Mesozoic, and Cainozoic. The appendix includes also a chronological analysis of the continents, and the characters of certain basins, in diagrammatic form. The treatment is interesting and readable, but here only a brief reference to certain points of interest can be attempted.

The author claims that several lines of inquiry lead to the conclusion that the origin of the earth must be placed at between 2000 and 3000 million years ago. Thus radio-active investigations show that the oldest known mineral is about 1750 million years old. Consideration of the spinal galaxies by Eddington and others suggests that the earth cannot be more than 2000 to 3000 million years old. The helium content of nickel-iron meteorites leads to the same conclusion. Lastly he quotes Jeffrey's conclusion that the age of the moon is probably less than 4000 million years, and that, from the study of the eccentricity of Mercury, the age of the solar system is probably nearer 1000 than 10,000 million years.

To a geologist however the most interesting section is that dealing with earth movements in past times. Taking the earth as a whole, an embarrassingly large number of periods of movement or "principal epochs of compression" have been recognized and named by different investigators. On p. 23 the author lists at least five between the late Precambrian and the end of the Lower Palaeozoic:

seven in the Upper Palaeozoic, five in the Mesozoic, and seven in the Tertiary. It is of interest that in the British Isles alone between the late Cambrian and the Pleistocene eighteen periods of movement have been recognized. It is obvious however that many of these are of local occurrence and minor significance, and the author therefore groups them into four principal epochs, viz. Caledonian, Variscan (which he prefers to Hercynian), Mesozoic, and Alpine. These major epochs overlap in time, and near their boundaries a particular movement may be assigned to the late part of one or the early part of another. It may be noted that Caledonian is thus used in a wider sense than is customary in this country, where it denotes post-Silurian, pre-Devonian movements. This may lead to some confusion, and it would have been preferable to have adopted another name. The same criticism may be applied to the use of Variscan and Alpine; and it may be suggested that Lower Palaeozoic, Upper Palaeozoic, Mesozoic, and Tertiary would have served the purpose better.

From the geographical point of view, perhaps the section of greatest interest is that dealing with Basins and Troughs. The author divides troughs into continental and deep sea, and for basins he suggests a new classification into two groups and four types as follows (p. 38): group 1, Marginal deep, Intramontaine trough; group 2, Nuclear basin, Discordant basin. The examples which he enumerates are of areas which have subsided and been occupied by a great thickness of sediments, so as to form geosynclines of various types. Many of them, but not all, have been subsequently crumpled up by earth movements. The deep sea basins which exist at the present time show many of the characteristic features of past basins, and it is suggested that the same classification may be applied to them. It is curious that one should have to arrive at conclusions regarding the origin of existing oceanic depressions from a study of fossil basins and troughs which have been completely destroyed. This is, of course, due to the fact that the ancient structures are more easily accessible than those under a great depth of water.

Though the reader may not always agree with the author's views, he will find this a stimulating book. O. T. J.

HISTORICAL GEOGRAPHY

TRATADO DOS DESCOBRIMENTOS. By ANTÓNIO GALVÃO. 3rd edition. Edited by the VISCONDE DE LAGOA and ELAINE SANCEAU. (Biblioteca historica, Série ultramarina No. 1.) *Porto: Livraria Civilização*, 1944. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches; 510 pages; illustrations.* 11*s*

This is the third Portuguese edition of Galvão's famous book on the history of discoveries down to the middle of the sixteenth century. The book was first published in 1563, six years after Galvão's death. The second edition is dated 1731. Richard Hakluyt published an English translation in 1601 under the title 'Discoveries of the world from their first original unto the year of our Lord 1555 by Antonio Galvano governor of Ternate.' In 1862 the Hakluyt Society republished the 1601 edition, together with the 1563 text of the original, and a few notes by Admiral C. R. D. Bethune.

The present book is the first critical edition of Galvão's work. It opens with an interesting introduction, or "biobibliographical study," on António Galvão, and then gives a faithful reproduction of the text of the first Portuguese edition, followed by a version in modern Portuguese. There is a long index, the usefulness of which might have been enhanced if some of the items, occasionally containing about one hundred entries, had been properly subdivided.

Galvão has been regarded primarily as a historian and a judicious and fair-

minded administrator during his governorship of the Moluccas in the difficult period from 1536 to 1539: one who could handle the pen as well as the sword. Viscount de Lagoa however sheds new light on Galvão's remarkable knowledge of nautical science and his skill as a navigator. At the same time, Galvão is shown to be a man of remarkable character, who could display as much "firmness as indecision, leonine intrepidity as revolting timidity." His weakness, which often did much harm and caused many difficulties, was chiefly shown when dealing with the intrigues and irregularities of his fellow countrymen, many of them enemies he had created by his inflexible uprightness. Viscount de Lagoa has not developed a blind love for his hero, a sin only too common among biographers, and thus gives for the first time a true and unbiased picture of a man to be numbered among those who honoured the name of Portugal in the East during the period of discovery and conquest. It must be added that, though Galvão's work as a historian has always been considered of great importance for the study of Portuguese and Spanish discoveries, it is often inaccurate and misleading, a point overlooked by many, including the present biographer.

No less interesting and valuable are most of the numerous notes which accompany the original text, explaining many obscure passages and identifying names of persons, things, and places. A few of these notes however are open to some criticism, which is only natural in a work of such scope. A few instances are worth mentioning. Hainan Island, at the entrance to the Gulf of Tonking, is confused with Annam (p. 84). Galvão says that Pero da Covilhã went to Sofala, and the note adds that he visited also Madagascar (p. 131); but no reason is given for the latter statement. There is no grounds for saying that Guli Guli is "Kolli-Kolli" (p. 171), a small stream (Kole Kole) on the east side of Piru bay, on the south-west of Ceram; Galvão's Guli Guli still exists under the name Gule Gule, or Goele Goele, a place on the south side of the south-eastern extremity of Ceram, exactly as shown in many early Portuguese maps and as intended by Galvão. The same applies to Tamao, at the entrance of Canton River, which is said to correspond to Sang-ch'wan (p. 182); it is now satisfactorily identified with Lin Tin Island, and according to the late S. F. Balfour it derived its Portuguese name from T'un Mun, which is the Chinese name for the Castle Peak Bay area in the New Territories of Hong Kong. It can hardly be suggested in fairness that Orellana betrayed Pizarro and his companions (p. 268) when, on 3 January 1542, he decided to continue downstream in the first voyage along the Amazon River; as a matter of fact, Orellana could not have returned to the point where he had left Pizarro.

These brief remarks are not intended to diminish the value of this important work, the need of which has long been felt, and which will be much appreciated by scholars and students of the history of early discoveries. A. Z. C.

ADDITIONS TO THE LIBRARY

EUROPE

THE HARLECH DOME, north of the Barmouth estuary

By C. A. Matley and T. S. Wilson (*Q. Journ. Geol. Soc.* 102 (1946) 1–40; maps)

THE GREAT GLEN FAULT. [Scottish Highlands]

By W. Q. Kennedy (*Q. Journ. Geol. Soc.* 102 (1946) 41–76)

THE SCHELDT QUESTION TO 1839

By S. T. Bindoff. $8\frac{1}{2} \times 5\frac{1}{2}$. xii+238 pp.; sketch-maps. *London: Allen and Unwin*, 1945. 10*s* 6*d*

The later history of the Scheldt question has been the subject of much study. In this monograph, the author traces it back to medieval times, relates its development to the changing physical conditions of the estuary, and provides interesting material on the economic history of Middleburg, Bergen op Zoom, Antwerp, and other cities.

STRUCTURE AGRAIRE ET PAYSAGE RURAL au Pays de Chimay. La Commune de Baileux

By O. Tulippe (*Bull. Soc. Belge d'Etudes géogr.* 13 (1943) 40–105; maps)

A detailed study of the development of rural settlement and exploitation in relation to the physical environment and social organization.

OESLING ET GUTLAND; morphologie du bassin ardennais et luxembourgeois de la Moselle

By G. Baeckeroot. $10 \times 6\frac{1}{2}$. 310 pp.; sketch-maps and illustrations. *Paris: A. Colin*, 1942

ÜBER KLIMAFAKTOREN UND ERNTEERTRÄGE IN FINLAND

By H. Lunelund. (*Comment. physico-math., Helsinki*, 12 (1944), No. 10, pp. 48; sketch-maps)

LA GARE DU NORD

By R. Closier. $10 \times 7\frac{1}{2}$. 294 pp.; diagrams. *Paris: J. B. Baillière*, 1940

A study of the Paris railway terminus.

A SELECT BIBLIOGRAPHY OF ITALY. A thousand books about Italy, its geography, population, etc.

By W. O. Hassall. 10×6. 82 pp. *London: Assocn. of Special Libraries*, 1946

SOME GLACIOMORPHOLOGICAL FORMS and their evidence as to the downwasting of the inland ice in Swedish and Norwegian mountain terrain

By C. M. Mannerfelt (*Geogr. Annaler*, 17 (1945) 1–240; maps and illustrations). [*In Swedish; English summary*]

VÄGARNA INOM NORRBOTTENS LÄN; studier över den trafikgeografiska utvecklingen från 1500-talet till våra dagar

By Gunnar Hoppe (*Geographica, Upsala, no.* 16 (1945) pp. 346; maps and illustrations)

A detailed study of the development of communications and traffic during the last five centuries in Norrbotten province. German summary.

ASIA

SOLUTION IN ASIA

By Owen Lattimore. $7\frac{1}{2} \times 5$. xxiv+144 pp. *London: Cresset Press*, 1945. 7*s* 6*d*

CLIMATE AND MAN IN CHINA

By Chi-Yun Chang (*Ann. Assocn. Amer. G.* 36 (1946) 44–73; illustrations and diagrams)

AN INTRODUCTION TO THE SOUTH-WEST PEOPLES OF CHINA

By Cheng Te-k'un and Liang Ch'ao-t'ao (*J. West China Border Research Soc.* 16A (1945) 23–38; map)

THE CHRONOLOGY OF PREHISTORIC NORTH-WEST INDIA

By Stuart Piggott (*Ancient India*, No. 1 (1946) 8–26; sketch-map and diagrams)

Ancient India is the Bulletin of the Archaeological Survey of India. The above paper analyses the Mohenjo-daro culture in relation to the other cultures on the Indian border, Persia, and 'Iraq.

A CLIMBER'S GUIDE TO SONAMARG, Kashmir

$8\frac{1}{2} \times 5\frac{1}{2}$. vi+52 pp.; sketch-maps and illustrations. *New Delhi: Himalayan Club*, 1945

HISTORY OF GEOLOGICAL INVESTIGATIONS IN SIBERIA. Fifth period, 1918–40. Pt. 5: The Siberian platform, Taimir region, and eastern Sayan. Pt. 6: Pre-Baikalia, Baikal uplands, farther Baikalia, and the Aldan Block. [*In Russian*]

By V. A. Obruchev. $10 \times 6\frac{1}{2}$. 126 pp., 118 pp. *Moscow: U.S.S.R. Acad. of Sciences*, 1945

AFRICA

THE MATABELE MISSION; a selection from the correspondence of John and Mary Moffat, David Livingstone and others, 1858–78. (Govt. Archives, S. Rhodesia: Oppenheimer Ser., No. 2)

Ed. by J. P. R. Wallis. 10×6½. xxxiv+268; map and illustrations. *London: Chatto and Windus*, 1945. 30*s*

CONTRIBUTION TO THE GEOMORPHOLOGY OF THE NATAL DRAKENSBERG

By F. Dixey (*Trans. Geol. Soc. S. Africa*, 48 (1945) 125–35)

EXPLANATION OF THE GEOLOGY OF DEGREE SHEET NO. 17 (KAHAMA)

By D. R. Grantham and others (*Tanganyika Geol. Div. Bull.* 15 (1945) pp. 40; geol. map on scale 1/250,000)

NORTH AND SOUTH AMERICA AND THE ARCTIC

MAPPING A HUNDRED YEARS OF CHANGE IN THE NIAGARA PENINSULA

By J. W. Watson (*Canadian Geogr. Journ.* 32 (1946) 266–83; sketch-map and illustrations)

NEWFOUNDLAND; a study of settlement

By Griffith Taylor (Canadian Inst. Internat. Affairs, Spec. ser.). 10×6½. 34 pp.; maps. *Toronto*, 1946

WAR BELOW ZERO; the battle for Greenland

By B. Balchen and others. 7½×5. 128 pp.; sketch-maps and illustrations. *London: Allen and Unwin*, 1945. 7*s* 6*d*

ETHNOGRAPHICAL COLLECTIONS FROM THE NORTH-WEST PASSAGE

By Kaj Birket-Smith (*Rept. 5th Thule Expedn.* 1921–24, vol. vi, No. 2, Copenhagen, 1945). 11×7. 298 pp.; illustrations

DEN ØKONOMISKE UDVIKLING I CHRISTIANSHAAB, JAKOBSHAVN OG RITENBENK DISTRIKTER, 1899–1938

By E. Friis-Nielsen and P. P. Sveistrup (*Meddel. om Gronland*, 134 (1944) No. 3, pp. 162; English summary; illustrations)

CHERÁN; a Sierra Tarascan village

By R. L. Beals (*Smithsonian Inst., Inst. of Social Anthropology*, publ. No. 2). 10×7½. x+226 pp.; sketch-maps and illustrations. *Washington*, 1946

A detailed study of the organization and culture of a Mexican Indian community. Though regarded as Indian "it is difficult to identify anything that is aboriginal besides its language and racial type."

GEOLOGICAL INVESTIGATIONS AROUND LAKE TITICACA

By N. D. Newell (*Amer. Journ. Sci.* 244 (1946) 357–66; sketch-maps)

NIVELACIÓN GENERAL DEL PAIS. [Argentina] (*Inst. Geogr. Militar, Publ. tecnica*, No. 6 (1945) 2 vols., pp. 360, 168; maps)

AUSTRALIA AND PACIFIC

AUSTRALIA'S MINERAL INDUSTRY IN THE PRESENT WAR

By H. G. Raggatt (*J. and Proc. R. Soc. New South Wales*, 77 (1944) 52–84; sketch-maps)

TIME SCALES IN THE DEVELOPMENT OF TASMANIAN PHYSIOGRAPHY

By A. N. Lewis (*Papers and Proc. R. Soc. Tasmania*, 1944, 19–40)

MANUFACTURING IN NEW ZEALAND: its outstanding characteristics

By J. L. Hewland (*New Zealand Geogr.* 2 (1946) 207–22; sketch-maps and illustrations)

DEPENDENT AREAS OF THE PACIFIC; an Australian view

By K. H. Bailey (*Foreign Affairs*, 24 (1946) 494–512)

FRAGMENTA PAPUANA: observations of a naturalist in Netherlands New Guinea

By H. J. Lam (*Sargentia*, vol. 5). 10×7. 196 pp.; illustrations. *Jamaica Plain, Mass.: Arnold Arboretum*, 1945

THE NATIVE CULTURE OF THE MARIANAS ISLANDS

By Laura Thompson (*B. P. Bishop Museum*, 185 (1945), 45 pp.; illustrations)

GENERAL

THE ANTARCTIC CONVERGENCE and the distribution of surface temperatures in Antarctic waters

By N. A. Mackintosh (*Discovery Repts.* 23 (1946) 177–212; maps)

GEOGRAPHIE DES ATLANTISCHEN OZEANS

By G. Schott. 3rd ed. 10½×7½. xvi+438 pp.; maps and illustrations. *Hamburg: Boysen*, 1944

BOLLETTINO DEL COMITATO GLACIOLOGICO ITALIANO. No 23, 1945

10½×7½. 136 pp.; maps and illustrations. *Torino*, 1945

MAINSPRINGS OF CIVILISATION

By Ellsworth Huntington. 8½×5½. xii+660; diagrams. *New York: John Wiley*, 1945. (28*s* 6*d*)

"This book is an attempt to analyse the role of biological inheritance and

physical environment in influencing the course of history." Part of it summarizes the contents of many earlier works by the author, but it contains new material, for example, on the theory of cycles

GLOBAL GEOGRAPHY

By G. T. Renner and associates. $8\frac{1}{2} \times 6$. 728 pp.; maps. *New York: T. Y. Crowell*, 1945

The purpose of this work is to assist American citizens "to view peoples, nations, and theatres of current events in their appropriate environmental settings." The four main sections deal with the physical elements, natural resources and industries, population, and political geography

ATLASES AND MAPS

EUROPE

ATLAS DE FRANCE. Sheets: 9 Morphologie, S.O.; 9A Morphologie, S.E.; 11 Géophysique; 30 Tapis végétal, N.O.; 32 Tapis végétal, S.O.; 50 Industries chimiques; 52 Industries diverses; 65 Carte chorographique, N.O.; 66 Carte chorographique, N.E.; 70 Santé Publique; 79 Ethnographie; 81 Langues et Patois. *Paris: Comité Nat. de Géogr.*, 1939–1941

GREAT BRITAIN. 1/625,000. Maps (in 2 sheets): Topography; Population density, 1931; Land utilisation; Land classification; Types of farming. *Ordnance Survey*, 1944. 5s each sheet

These maps have been compiled by the Ministry of Town and Country Planning, in cooperation with other official bodies and the Land Utilization Survey.

SVERIGES GEOLOGISKA UNDERSÖKNING. 1:50,000. Sheets: Hedemora, Horndal, Lidköping Lummelunda. *Stockholm: Sveriges Geologiska Undersökning*, 1940–1943

ASIA

STANFORD'S GENERAL MAP OF CHINA. 1:3,050,000. *London: Stanford* [1945]

INDIA. 1 INCH MAP (1:63,360). Sheets: 56K–5, 58B–9. *Calcutta: Survey of India*, 1945

AFRICA

EGYPT. 1:100,000. Normal series. 25 sheets. 1:500,000. 12 sheets. *El-Giza: Survey of Egypt*, 1940–45

INTERNATIONAL MAP OF THE WORLD, 1/1M. Sheets: Alexandria, Cairo, Dakhla, Uweinat. *El-Giza: Survey of Egypt*, 1941–1945

ATLAS OF THE GOLD COAST. 4th edition. *Accra: Gold Coast Survey Dept.*, 1945

TANGANYIKA TERRITORY. Aviation Route Maps. 1/1M. 11 sheets. Compiled and printed by the Survey Division for Dept. of Civil Aviation. *Dar-es-Salaam*, 1944–1945

UGANDA PROTECTORATE. 1:250,000. Sheets: Ankole, Busoga, Kigezi, Mubende, Teso. *Entebbe: Survey Land and Mines Dept.*, 1945

AMERICA

CANADA. NATIONAL TOPOGRAPHIC SERIES. 1:63,360. Sheets: 21N–8, 41A–2, 41A–3, 41A–5 and 6, 41A–7, 41A–9, 41A–10. Surveyed and reproduced by the Geographical Section, General Staff, Dept. of National Defence. *Ottawa: Dept. of Mines and Resources*, 1945–1946

CANADA. BRITISH COLUMBIA. 1/1M. 4 sheets: *Victoria B.C.: Dept. of Lands and Forests*, 1945

UNITED STATES. Oil and Gas Map of Illinois prepared by Alfred H. Bell and David H. Swann. 1:500,000. *Urbana: Division of the State Geological Survey*, 1945

SOUTH AMERICA. 1/1M. Sheets: N.B–18 (Bogota), N.C–19 (Caracas). Compiled and drawn by the American Geographical Society. *New York:* 1945

AUSTRALIA

AUSTRALIAN AERONAUTICAL SERIES. Lines of Equal Magnetic Declination as at June 1942. Compiled and drawn by the Property and Survey Branch. Sheet 1, Australia 1:5,500,000. Sheets 2 and 3, East Indies, Australia, and Western Pacific 1:10,375,000. Canberra: *Dept. of the Interior*, 1944

THE MONTHLY RECORD

THE ROYAL NETHERLANDS GEOGRAPHICAL SOCIETY

When Professor Austin Miller visited Holland recently to address the Utrecht branch of the Royal Netherlands Geographical Society on Rural Planning in England and Wales, he was the bearer of a letter of greeting from the President and Council of our Society. This was received with warm appreciation by the Utrecht branch, and forwarded to the President of the Society in Amsterdam. We have since received from Dr. L. F. de Beaufort a letter expressing the pleasure of himself and his Council on receiving the message, and their sincere hope for the renewal of the traditional friendship and cooperation between our two Societies. They were particularly glad that the first foreign visitor to address their members since the war should have come from Britain.

FEES FOR INSTRUCTION IN SURVEYING

In the September–October 1945 issue of the *Journal* we announced the arrangements for instruction in surveying and the courses available at the House of the Society. It has since been possible to fix the fees for these courses. The fee for one hour's theoretical instruction is 15*s*. for one student, 10*s*. if two students are in attendance, and 7*s*. 6*d*. if three or more are in attendance. For practical instruction the fee is 10*s*. an hour without reduction, since instruction is always individual. In the case of students who are Fellows of the Society at the beginning of the course, or are elected Fellows during the course, there is a reduction of one-third in the fees.

Further information about the courses may be obtained from the Instructor in Surveying, Mr. Alfred Stephenson, at the Society's House. Candidates should write stating the exact purpose for which they require instruction.

RESEARCH FELLOWSHIPS FOR WORK IN THE CANADIAN ARCTIC

The Arctic Institute of North America is offering two Fellowships of up to $2000 each (Canadian currency) for scientific work in the Canadian Arctic or Subarctic during 1947. The Fellowships are open to any one who has demonstrated his ability to carry out research work of superior quality in some field of science. The Fellowships will be awarded on the recommendation of the Board of Governors of the Arctic Institute, and will be announced by February 1947. Applications must be received by 1 November 1946. Application forms may be obtained from The Arctic Institute of North America, 805, Sherbrooke Street West, Montreal, Canada.

The 1946 Fellowships of $1500 each, announced in the November–December 1945 issue of the *Journal*, were awarded to Dr. Margaret Lantis, of Washington, D.C., for ethnologic study of the Eskimos on Nunivak Island, Alaska, and to Mr. Harold C. Hanson, of the Illinois State Natural History Survey, for wild-life research on the west coast of James Bay, northern Ontario. An additional grant of up to $1500 was made to Dr. Nicholas Polunin, of Oxford University, for botanical work on Ungava Peninsula.

THE CENTENARY OF THE HAKLUYT SOCIETY

In November the Hakluyt Society will celebrate its centenary. Its foundation was a result in part of the general interest in geography and exploration which arose in England early in the last century, in part of the contemporary wave of

emigration to the lands which now form the British Commonwealth. Its object was to publish the original narratives of explorers, voyagers, and travellers of all nations which had remained in manuscript or had been printed in uncritical or inaccurate versions. One hundred and ninety-two volumes have now been issued to members, and thirty-four extra volumes, among them Richard Hakluyt's 'Principal Navigations of the English Nation,' have also been published. All foreign works are translated into English, and each contains a full introduction and footnotes to the text. The publications deal with many countries and periods, ranging from the records of the early maritime explorers to Peter Mundy's shrewd descriptions and drawings of life in seventeenth-century Europe and the fascinating stories of travel in the Far East collected in Yule's 'Cathay and the way thither.' Officers of the Royal Geographical Society and of the British Museum have throughout taken a prominent part in its work. Two of its Presidents, Sir Roderick Murchison and Sir Clements Markham, were Presidents of the R.G.S., and seven of its Honorary Secretaries and one President have come from the British Museum.

In 1945 Sir William Foster retired from the office of President after many years of distinguished service, and was succeeded by Dr. Edward Lynam of the British Museum. The present Hon. Secretary is Mr. R. A. Skelton of the British Museum, from whom further particulars of the Society may be obtained.

OCEANOGRAPHIC WORK IN THE MEDITERRANEAN

Professor Hans Pettersson, Director of the Oceanografiska Institutet at Göteborg, sends us the following account of his oceanographic work in the Mediterranean on his recent cruise with the Swedish research ship 'Skagerak':

The new core-sampling technique of studying sediments on the sea floor, developed during the war years by the Oceanografiska Institutet in Göteborg in cooperation with the Svenska Hydrografisk-Biologiska Kommissionen, was necessarily first applied in the moderate depths accessible within or near Swedish territorial waters, where it gave undisturbed sediment cores up to more than 20 metres (nearly 70 feet) in length. These results opened up prospects of applying the same methods in oceanic depths for coring deep-sea deposits down to previously unattainable levels and, by this means, to study many fundamental problems in oceanography and in submarine geology. A few years ago, through the generosity of private donors in Göteborg, the financial support needed for a Swedish deep-sea expedition round the world was given to the Royal Society of Göteborg.[1] The loan for fifteen months at net running cost of their new training ship, the *Albatross*, was generously promised by the Broström shipping concern of Göteborg.

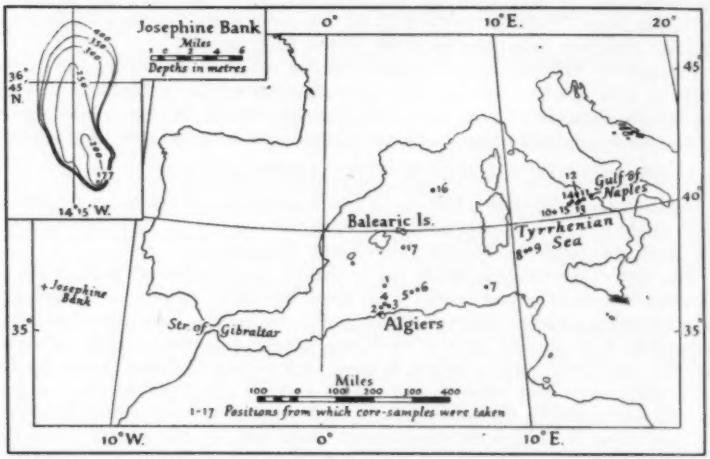
Before undertaking the cruise, it was necessary to submit the new instruments and methods to more searching tests in greater depths than those hitherto accessible (viz. 700 metres). On representations from Svenska Djuphavs expeditions Nämnd, which had been appointed to organize the cruise, and with a strong recommendation from the Kommission, the Swedish Government authorized the Kommission to use its research ship the *Skagerak* for a preliminary cruise to the western Mediterranean, starting from Göteborg in early April of this year, and expected to last for two and a half months. It was decided that the same cruise should be used to test in great depths a new method of measuring by echo-sounding the distance from the sediment surface down to the underlying substratum, devised by Professor W. Weibull of the Bofors Armament Works. We are much indebted to A. B. Bofors for allowing

[1] Göteborgs Kungl. Vetenskaps- och Vitterhetssamhälle, which is also the owner of Oceanografiska Institutet.

Professor Weibull and his assistant, Mr. Lundgren, to take part in the cruise, and also for lending the necessary instruments. The staff included also Dr. B. Kullenberg and Kand. G. Arrhenius.

The Western Mediterranean was chosen as our field of work partly because of the fair-weather conditions generally prevailing there in April and May, which would considerably facilitate our work with the very heavy gear to be used, and partly because I hoped to find numerous horizons of volcanic ash in the deposits there. Such horizons, besides their very great interest *per se* and the prospects of obtaining datable ash-layers from historic outbreaks, are important as a control of the undisturbed nature of the cores, since any deviation from the natural stratification *in situ* will become apparent through corresponding deformations in the ash-zones.

The course followed and the positions where cores were sampled or measure-



ments were made are plotted on the accompanying map. The length of the cores and the depth below the sediment surface from which Professor Weibull obtained echos are set out in the Table opposite. Except in a few cases where, owing to the hardness of the bottom or for other reasons, the core-sampler gave relatively short cores or none at all, the cores ranged in length between 6 and 15 metres. The rather worn state of the old winch on board the *Skagerak*, which was not constructed for such heavy strain, often limited the length of the coring tube to 11 metres. In two cases a tube 16 metres long was used with satisfactory results.

Our expectations were amply justified. The piston-sampler constructed by Dr. Kullenberg—a modification of the original vacuum core-sampler—secured practically undisturbed cores down to a maximum depth of over 3600 metres. A very great number of volcanic ash-zones, sometimes exceeding one hundred in a single core, were found, especially in the lower parts of the cores taken near the Algerian coast, testifying to a volcanic activity considerably reduced during the last few thousand years and probably mainly localized to craters now submerged.[1] In the Tyrrhenian Sea the volcanic horizons were much less

[1] According to Algerian geologists there has been no volcanic activity on the adjacent coast in post-Tertiary time.

numerous, except in two cores taken off the Gulf of Naples; and two cores taken not far from the Balearic Islands yielded still fewer. There were also distinct differences in the colour of the ash, which was quite dark near the African coast and distinctly greenish in the Tyrrhenian Sea—a sign of the more basic character of the ejecta. Often there was a perceptible colouring of the clay or ooze immediately above an ash layer, dark in the southern, greenish in the eastern localities, presumably due to a rain of very fine ash particles persisting for several years after an outbreak. Most of the ash-zones were quite thin (a few millimetres or even less), but in some cases they were several decimetres in thickness, the maximum being 75 centimetres.

	Latitude N.	*Longitude E.*	*Depth*	*Length of core*	*Sediment thickness*
1.	37° 50′	3° 11′	2,540 m.	10 m.	—
	37 50	3 11	2,420	10	—
	37 50	3 11	2,450	15	—
2.	37 00	3 00	2,620	10	—
3.	37 03	3 21	2,320	8	—
4.	37 09	3 11	2,710	9·5	—
5.	37 35	4 35	2,810	10·5	460, 480 m.; mean 470 m.
6.	37 38	4 52	2,804	—	600 m.
7.	37 37	8 26	2,654	—	620, 640 m.; mean 630 m.
8.	38 52	10 35	2,440	10	530, 535, 540 m.; mean 535 m.
9.	38 56	10 50	2,620	15	—
10.	40 14	12 19	3,620	10	2700, 2760 m.; mean 2730 m.
11.	40 37	13 57	870	0*	0 m.
12.	40 34	13 43	1,030	0·9†	0·9 m.
13.	40 31	13 38	1,116	0·6†	0·6 m.
14.	40 36	13 20	1,990	6	—
15.	40 31	13 10	2,720	8	—
16.	41 29	5 51	2,680	9	—
17.	39 20	4 12	1,850	10	—

* Hard bottom; no core obtained.

† Length of core down to hard bottom, taken with the Ekman sounder.

In some of the cores there were layers rich in mollusc shells, and in a few cases vegetable fibres also, fairly densely packed. A still more unmistakable sign of changes in level was found in a core taken off the Gulf of Naples: a layer of broken pieces of shale, apparently somewhat rounded as by wave action, which stopped the core-sampler at a depth of nearly 6 metres below the sediment surface. Near the Balearic Islands there were, in the lower levels, zones coloured dark by sulphide of iron (FeS), the same substance occasionally also forming small concretions. The lower state of oxygenation which must have prevailed when these layers were formed may be attributed either to a more copious supply of organic matter from above, or to a more restricted circulation of the bottom water than at present.

Further and more detailed study of these cores may be expected to yield an unique record of the volcanic activity in the western Mediterranean during the late Quarternary Age.

The echo-soundings of sediment thickness carried out by Professor Weibull between Algiers and the Tyrrhenian Sea were also successful. His results (given in the last column of the Table) indicate a reflecting layer, probably rock,

situated at a depth below the sediment surface varying between 470 and 2700 metres,[1] which was the maximum value found in the greatest depth of the Tyrrhenian Sea. In a few cases, where the sediment layer was very thin or hardly present at all, the echo-sounding gave values agreeing with those indicated by the core-sampler. There is every reason to believe that the new method, with certain improvements—such as exploding the charge in the sediment surface or immediately below it, instead of at moderate depths in the water (300–500 metres)—will make it possible to measure also the thickness of oceanic bottom deposits on the *Albatross* expedition. The great service done to oceanography by Professor Weibull through developing this method can hardly be over-estimated.

During the last part of the cruise, biological work by deep trawling, dredging, and dragging great pelagic plankton nets was carried out west of the Straits of Gibraltar and out to the Josephine Bank, under the direction of Dr. O. Nubelin, Director of the Natural History Museum of Göteborg. By means of the Hughes echo-sounder, and by operating round buoys anchored on the crest of the Josephine Bank, the upper parts of the bank were surveyed (see inset map). The minimum depth encountered near the south-eastern edge of the bank, where the slope is very steep, was 177 metres or 97 fathoms (the newest Admiralty chart gives 83 fathoms).

In general, the results of this preliminary cruise justify the expectation that the new methods will prove equally successful during the forthcoming cruise with the *Albatross*.

AWARD TO PROFESSOR DE MARGERIE

At the Annual General Meeting of the Geological Society of London on 13 March 1946, the Wollaston Medal was presented to Professor Emmanuel de Margerie in appreciation of his services to geological science. In presenting the medal the President, Professor A. E. Trueman, gave a brief survey of Professor de Margerie's long and distinguished career, and mentioned a few among the succession of his authoritative works on structural geology, beginning in 1888 with 'Les Dislocations de l'Ecorce terrestre' with Heim and 'Les Formes du Terrain' with La Noë. Professor de Margerie spent nearly fifty years in studying the structure of the Jura, and his joint work with General de La Noë made that area the classic example of topography adapted to folding. The results are assembled in his major work, 'Le Jura,' which appeared in 1922 and 1936. Outstanding among Professor de Margerie's other services to geology and geologists have been his contributions to geological literature through his work on the cataloguing of geological bibliographies, his critical analyses of geological researches, and, above all, his translation of Suess's great work.

Professor de Margerie replied in English, expressing his appreciation of the honour bestowed upon him, and referred to the work of previous Wollaston medallists.

AGRICULTURE IN SWITZERLAND, 1939–1945

The expansion of arable cultivation in Switzerland to meet the demands of the economic conditions during the war is described by F. T. Wahlen in 'Das Schweizerische Anbauwerk 1940–45' (*Neujahrsblatt Naturf. Ges. Zurich*, 1946, No. 148). Profiting from experience in the years 1914–18, steps had been taken from 1932 onwards to anticipate a decline in food imports: reserves had been built up, and preparations made to expand the area in wheat and potatoes and

[1] Subject to a correction for the higher velocity of sound in the sediment than in water, which is at present being determined at the Bofors laboratory.

to establish a balance between grain and fodder crops. It was clear that to have a substantial effect on the domestic food situation, the expansion of the arable must be very considerable: in pre-war years for example there were two hundred and forty-two inhabitants for each square kilometre of all farm land. To obtain the information required to plan for the optimum arable area, a detailed farm survey was begun in 1940. The basis of the survey was the commune, and the data were collected and collated by representatives of the commune, the canton, and the government in cooperation. Each commune was divided into sections, averaging 20–40 hectares and defined by conspicuous features, *e.g.* watercourses, woods, bare rock surfaces. Maps based on the 1/25,000 sheets of the Siegfried Atlas with additional information from air photographs were prepared, upon which the use and agricultural value of the land was recorded. As a thorough scientific survey was impracticable, the quality of the land was gauged by certain broad criteria: ease of working largely from the humus content and texture of the soil; productivity from the occurrence of typical grasses and weeds in the meadows, and its general character from topography, exposure, and accessibility. Areas with a slope of about 25° or more were classified as non-arable. In estimating the optimum arable area, questions of farm organization, and in some cases psychological considerations, were given weight. In addition, the reserve area, that is the area which, when drained, provided with farm roads, or otherwise improved, could be brought into cultivation in an extreme emergency, was also calculated. From the data thus obtained, the additional area to be brought into cultivation each year was calculated by the Federal authorities, and quotas allotted to the cantons. As a result the area under the main food and fodder crops almost exactly doubled between 1934 and 1944, expanding from 183,500 to 365,900 ha., while stock declined, *e.g.* milch cows from 910,000 to 805,000, and pigs from 959,000 to 698,000. In regard to the position of animal husbandry, it is pointed out that the million hectares of Alpine pasture provide 6 per cent. only of the fodder consumed. These developments naturally required a greatly expanded labour force, which was drawn from industry, commerce, and colleges. These additional workers numbered 63,300 in 1942, and 145,000 in 1944: in that year approximately one-third were women.

PROPOSED NATIONAL ATLAS OF CANADA

Canada was one of the first countries to produce a national atlas. The first edition of the 'Atlas of Canada,' edited by Mr. James White, appeared in 1906; and ten years later a second edition, revised and enlarged, was issued. The latter contained eighty pages of maps, with numerous statistical diagrams, giving a generalized representation of relief and geology, minerals, distribution and composition of the population, railways, and boundaries. The largest scale of the general maps was 1/6·3M approx., and most of the regional maps were on the scale of 1/2·2M. In the last thirty years, the use of cartographic representation of distributions has been widely extended, and the technique developed, while the material available for an atlas of this type has much increased. At a meeting of the Canadian Social Science Research Council in January 1943, a small committee was appointed to consider the possibilities of preparing and publishing a new and comprehensive Atlas of Canada, and a preliminary survey of the project by Professor B. Brouillette has recently been published (Ottawa, 1945).

After consulting a number of specialists, and analysing the contents of other national atlases, the author outlines a general scheme for the contents, modelled to some extent on that of the 'Atlas de France.' He emphasizes that the maps in an atlas of this character should be the result of specialized research, and that

the initiation and coordination of such research requires government and academic cooperation in an agreed plan.

The greater part of the pamphlet consists of a useful summary of the activities of the various Dominion and provincial map-producing offices, and of the cartographic material now existing. The work of survey and map reproduction is mainly divided between the branches of two Departments, Mines and Resources and National Defence. The two relevant branches of the former are the Hydrographic and Map Service and the Bureau of Geology and Topography. The Hydrographic Service surveys and produces charts of Canadian coastal and inland waters; these are printed for it by one of its sections, the Legal Surveys and Map Service, which also acts as the main distribution agent for Dominion Maps, with the exception of the hydrographic charts and geological maps. The Bureau of Geology and Topography is divided into two main sections, the Topographical Survey and the Geological Survey. The former carries out surveys and prepares maps, primarily as a base for geological editions, though for some areas these are the only topographical maps available. They do not form part of the National Topographic Series. This is mainly the work of the Geographical Section, General Staff, Ottawa (Department of National Defence) which carries out field survey, air photography, drawing, and reproduction. The Topographic Series is the basic map of Canada, and is produced on four scales, at 1 mile, 2 miles, 4 miles, and 8 miles to the inch. The 1-mile-to-the-inch maps cover principally the more developed areas in Ontario and southern Quebec; the 8-miles-to-the-inch cover the country completely. The maps are distributed by the Legal Surveys and Map Service.

The Geodetic Survey of Canada, a section of the Department of Mines and Resources, carries out primary triangulation, precise levelling, and geodetic operations. It does not directly publish maps, but supplies the other services with original control data. Maps produced by other services such as the Forest Service, Water and Power Bureau, and Bureau of the North West Territories, mainly show information overprinted on topographic maps. The Experimental Farms Service, for example, have published a number of detailed soil maps, lithographed in many colours, based on the National Topographic Series where available. Most of the cartographic work is done for this Service by the Hydrographic and Map Service.

SURVEY IN ARABIA

During the last two winter seasons an expedition from the Survey of Egypt under Ibrahim effendi 'Azzam has been busy in Sa'udi Arabia. They have measured bases near Mecca and Madina with geodetic accuracy, connected the two by triangulation, and are in course of mapping the usual route between the two Holy Cities on the 1/100,000 scale. A town map of Madina on the 1/10,000 scale and a number of 1/1000 field sheets of a special area at Muna near Mecca have reached Cairo. Two special 1/100,000 maps of Mecca and Jidda with inset sketch-plans of both cities have already been published by the Survey of Egypt. It is hoped to continue the work next season. G. W. M.

ANCIENT ARABIA: CORRECTION

We regret that a wrong bibliographical reference was given in the paper by Dr. P. B. Cornwall in the January–February *Journal*. Footnote 3 on p. 44 should read "See *Le Muséon* 50 (1937) 239–68."

CORRESPONDENCE

THE CYRENAICA–TRIPOLITANIA BOUNDARY

In the May–June, 1945, number of the *Journal* I wrote a note on the future of Cyrenaica. Mr. Kennedy Shaw has written in the September–October number of the same year a complementary note on the future of Tripolitania. I would like, in view of what he says in his most courteous letter, to add some further remarks on the question of the boundary between these two parts of Italian Libya.

There is a possibility of the two countries coming under a single administration set up by the United Nations. I agree that this might be the most satisfactory arrangement, but it is feasible also to have separate administrations under a single controlling body. The obstacle to a single administration is that, while it is acknowledged by all that al-Sayyid Muhammad Idris al-Sanusi must be the titular head of the Cyrenaican Arabs, the Tripolitanian Arabs of the coast might not be prepared so readily, if at all, to accept his leadership. Were this to happen the Cyrenaican Arabs might, and I think would, ask for a rectification of the present boundary between Italian Tripolitania and Italian Cyrenaica. Mr. Kennedy Shaw considers that the best line between the two countries would run "from the north-eastern corner of Tibesti, west of Tazerbo, up the east side of the Harug el Asuad, between Zella and Marada to reach the sea in about long. 19° E." I cannot agree that this would be the best line, because it conflicts with the political and ethnological facts on which the Sanusi Arabs of Cyrenaica, including those of the Sirtica, base their claim.

There has never been a hard-and-fast frontier between Cyrenaica and Tripolitania. Both countries came under the same foreign domination, first of Turkey and then of Italy, so that the frontier between them was no more than an administrative convenience. Under the Turks the *Caza* of Sirte depended at first on the *Mutasarrafiya* of Benghazi which, in its turn, depended not on Tripoli but directly on Stamboul, for though the *Mutasarrafiya* formed part of the *Vilayet* of Tripoli it did not come under it administratively. About 1847 the *Caza* of Sirte passed to Tripolitania, being attached to the *Sandjak* of Homs. But neither the Turks nor the autonomous Caramanli dynasty at Tripoli (1711–1835) ever gained effective control over the Sirtica. The Italians first placed the Sirtica directly under Tripoli and later, in 1934, when the whole of Libya was divided into four Departments and a Military Zone of the Sahara, it was administered from Misurata. However it was not till 1929–30 that they consolidated their position in it. Till that time the whole of the Sirtica came under Sanusi influence, and part of it at any rate seems to have been recognized as coming within the Sanusi sphere of administration under the Italo-Sanusi agreement of al-Rajima (1920), broken by the Italians early in 1923.

But the Cyrenaican case is essentially one of sentiment. The Beduin of the Sirtica have always followed the Sanusi family and fought against the Italians as Sanusi adherents. Their exiled leaders in Egypt wholeheartedly supported the Sayyid when he offered the assistance of his people to Great Britain during the late war. These Beduin therefore feel that, if there are to be separate administrations, they should be included in Sanusi Cyrenaica. In view of this feeling my superiors in Cyrenaica permitted me to make a six weeks' tour of the Sirtica and the oases of its hinterland to ascertain the facts, and I would like to

record very briefly the conclusions I came to on the boundary question. I write only of the Sirtica, not of the Fezzan.

The present boundary (that drawn by the Italians between the Commissariats of Misurata and Benghazi) is unsatisfactory on political and ethnological grounds. It cuts the entirely Sanusi tribe of the Magharba in two and the Ra'idat section, at present in Tripolitania, have repeatedly asked to be included in Cyrenaica. Their request is incontrovertible. Their inclusion would mean the extension of Cyrenaica westwards to the Wadi Harawa (Haraua) in about long. 17° E. In this Wadi live most of the remnants of the Aulad Suliman tribe, who are strongly Sanusi and fought the Italians doggedly under the Sanusi flag. If this Wadi were to be the frontier line it should therefore be included in Cyrenaica, and the line should run southwards to include also the entirely Sanusi oasis of Zella. The Wadi Harawa–Zella line would mean the addition of about six thousand souls to Cyrenaica. The added territory could easily be administered from Agedabia. This line has the further convenience that it is the line which divided the Italian districts of Sirte and En-Nofilia, so that the alteration would simply mean that an administrative district would be detached from Tripolitania and attached to Cyrenaica to meet the unanimous wishes of its inhabitants.

Sanusi claims are more considerable. The line the Sayyid would probably ask for is the Buerat Hsun–Socna line, about long. 16° E., to include the Sanusi Qadhadhfa tribe, other tribal fractions which adhere to the Sanusiya order, and the oases of Socna, Hun, and Waddan which are also in the main sympathetic to it. This line would mean the addition of two Italian administrative districts and about twenty-two thousand souls to Cyrenaica. There is a very strong case to be made out on ethnological and political grounds for the inclusion of the whole of this territory in Cyrenaica, but from an administrative point of view it is open to question whether the country would gain by an extension of its frontier so far westwards. Maintenance of communications and administration over so extensive an arid region might prove too great a tax on its very limited resources. This applies even more to the Wadi Zamzam line running south to include the eastern Fezzan, which some Sanusi adherents in Tripolitania ask for, though on purely ethno-religious grounds a case could be made out for including even the eastern Fezzan.

I conclude therefore that, whilst consideration should be given to claims to a more western frontier, the Wadi Harawa–Zella line must be regarded as an essential minimum concession to Sanusi requests if justice is to be done and future friction avoided. In my opinion it is in Sanusi Cyrenaica's interests that her frontier with Tripolitania should not be farther westwards than the Buerat Hsun–Socna line and not farther eastwards than the Wadi Harawa–Zella line.

1 *April* 1946. E. E. EVANS-PRITCHARD.

METHODS OF SURVEY

I am deeply appreciative of the remarks made by the President, Lord Rennell, in his recent letter (*Geogr. J.* 105 (1945) 227) in which he commented on my paper describing war-time surveys in the Libyan Desert.

Unfortunately however I cannot entirely agree with his recommendation that all expeditions sponsored by the Society should adopt the practice outlined therein of working out and plotting their observations in the field. Before the war I was on two Arctic expeditions, and we then evolved a procedure which was almost diametrically opposite, in that we returned to the base—and even to

England—with the survey material still in the form of recorded observations and undeveloped films. I have given details of these methods in the papers which were written after the return of the expeditions, and I also wrote a general note on survey methods on Polar expeditions for the *Polar Record*. Later experience has not changed my view that they were the most suitable for that type of expedition. May I therefore take a little of your space to justify these apparently inconsistent views, to both of which I still adhere?

In my opinion there are three main factors which account for the difference. First of all, and by far the most important, conditions on the average desert expedition by car are extremely comfortable—especially as regards the observations—compared with those on a spring journey in the Polar regions. When one stops the car to plot the course and take bearings one's hands are warm, and the only troubles are, sometimes, a strong wind and a hot sun which were not felt while the car was moving.

But in the temperatures of a Polar spring hands are always painful during observations, and can only be bared for a few minutes at a time; there is usually a wind to add to one's grief, and one is sometimes troubled by such things as frozen breath covering the sketching-board with a film of ice. The general unpleasantness of the conditions on an average Polar mountain-top make it impossible for the strongest-minded man to do the necessary calculations and reasoned thinking required for computing and plotting his observations. All he can do is to carry out the observations as quickly as possible and hope not to make mistakes in them.

In the camp, though the contrast is less, it is still there, and one has not the time that is available on car journeys, where other members of the party do the camp chores. On the average sledge expedition of two or three men every one must take his turn at cooking and pitching and breaking camp and feeding the dogs, etc.; and to compute the observations in the field (which I tried at first) is to cut down the time available for the observations themselves. In the comparatively short field season of the Polar regions this is, I think, a mistake.

The second factor is weight. In a car an extra instrument such as a plane-table does not make any appreciable difference to the load. There is no question of carrying the instruments about on foot more than a few yards, because the speed of foot travel compares so unfavourably with that of a car that it is uneconomic to start climbing large hills to get a long view—one may just as well go and see in the car.

But in Polar work every pound counts, even when one is dog-sledging (as opposed to man-hauling), and only essential instruments can be carried. Moreover, one's observations should be taken, for reasons given below, not from the sea-ice or ice-cap, but from mountains which give a good view. It is in climbing these that the weight of an extra instrument makes itself felt. Most British Polar surveyors have, I think, so far tampered with the Society's instruments as to remove the extensible part of the theodolite legs, which shows the lengths to which one will go to save a few pounds of weight. When I was going on my first expedition, the late Michael Spender, from his experience with the Danes in east Greenland, advised me that a plane-table was not worth while for anything but small local surveys: and so I found. The theodolite has to be taken up to the station to establish control; why then take another instrument for detail work when the necessary bearings can just as well be made with the theodolite?

The third factor is the speed of travel and its effect on the survey methods, and consequently on the ease or difficulty of working them out. In desert work by car, distance is a simple matter of differences between speedometer readings,

and directions are plotted directly from the sun compass readings In the Polar regions, on expeditions not equipped with motor sledges or aeroplanes, this form of measurement is generally only used in featureless areas such as ice-cap or the flat tundras of northern Canada.

Elsewhere, the modern tendency has been to visit a comparatively small number of mountain stations, each tied to an astronomical fix, and also connected by a triangulation which is usually rather rough. Distances are obtained either from differences of the astronomical positions or from short bases extended by subtense methods, both of which require considerable computation. The modern optical theodolite is a remarkably flexible and powerful instrument, and can be used for almost every survey operation: measuring angles, distances, and heights, and giving one a fixed point from which to start. But all these uses involve computation, and to do this in the field is to take up time which could be used for travel or more observations. In these difficult conditions one will make mistakes and possibly spoil the original records of the observations.

My policy was therefore to do no computation at all, other than that required to give one a rough map for immediate use; this could be done by obtaining latitudes from meridian altitudes and true bearings from a horizontal reading to the sun at culmination. Most of the observations were to the sun and not to the stars, and this adds considerably to the time required for working out the results, owing to the necessity of interpolating the sun's declination and equation of time. In order to reduce the effect of gross errors in observation as much as possible, we always observed to every control point visible from a station, and the sun was included in the round of angles as a matter of course.

In addition, in Ellesmere Land in 1938, we used a small camera which had been fitted to the Society's Wild theodolite, and a round of photographs was taken with this at every station. We thus reduced the work at a station to two hours at the most, if we occupied a short base, and that was about as much as we could stand on many of them. Yet we had taken, in effect, a bearing and a vertical angle to every single point visible from that station, because the photographs were calibrated. Thus we accumulated a mass of completely undigested observations which had to be sorted out at leisure in the office at home or, if we were spending a second year, at the base during the winter. I still believe that for Polar work it was the best policy.

If I may presume to add one or two riders to Lord Rennell's recommendations they would be as follows. That the Society should ensure that every expedition has allowed in its programme and budget for a period after its return during which the surveyors (and not the Society's draughtsmen) will work out and plot their results. In many pre-war expeditions the surveyors went straight off to jobs after their return, and the full use of their observations has never been made. Secondly, that the Society should insist on neatness and clarity of the records, and that they should be properly indexed and deposited either in its Library or with a permanent institution such as the Scott Polar Research Institute at Cambridge. Thirdly, that more use should be made of small precise cameras fitted to precision theodolites. The proper photo theodolite is too heavy for much Polar work, and the mountain models produced, for example, by Zeiss before the war are only suitable for work in regions such as the Himalayas, where control already exists and one is not obliged to take astronomical observations. These theodolites only read to minutes, and it is necessary to take another theodolite for astronomical work, in areas where one is establishing one's own control. Had I been able to take such a camera in Libya we should have been able to add real detail to the map, instead of only sketching the main features and being reduced to descriptive notes for the rest. I believe very firmly in the

future of this type of instrument for exploratory work, especially in difficult conditions such as are found in the Polar regions or in high mountains.

6 *February* 1946. J. W. WRIGHT.

ANNUAL GENERAL MEETING

Annual General Meeting, 24 June 1946. The PRESIDENT, The Right Hon. The Lord Rennell of Rodd, in the Chair.

The HON. SECRETARY, Brigadier Sir Clinton Lewis, read the Minutes of the Annual General Meeting held on 25 June 1945, which were confirmed, and signed by the President.

The PRESIDENT then said: The first duty I have to perform this afternoon is to present the Medals and Awards to various recipients. The Royal Medals, the Founder's Medal and the Patron's Medal are granted by His Majesty the King, our Patron, and are the most coveted geographical awards. This year, as in former years, these medals must for the time being be represented by certificates of award, the medals themselves being dependent on the release of gold.

H.M. the King has approved the award of the Founder's Medal for 1945 to Dr. Charles Camsell, C.M.G., for his contributions to the geology and geography of the Canadian North and his work in advancing geographical science in the Dominion.

Dr. Camsell was born in the North West Territories and throughout his career has been closely associated with their development. In 1900–02, he accompanied Dr. Mackintosh Bell's Geological Survey Expedition to the Great Bear Lake, and distinguished himself in the difficult traverse of the Yellow Knife Preserve. His later work includes the exploration of the Taltson River in 1914, and flights over the northern Rockies in 1933. Now Chairman of the Council of the North West Territories and Deputy Minister of the Department of Mines and Resources, he has much responsibility for the survey, development of resources, and settlement of these great territories, which are already playing and must play an increasingly important role in the future of the North American continent. Finally, as President of the Canadian Geographical Society, Dr. Camsell is contributing much to the diffusion of geographical knowledge among the general public.

With the approval of His Majesty the King, the Council have awarded the Patron's Medal for 1946 to Sub-Inspector Henry A. Larsen of the Royal Canadian Mounted Police, for outstanding achievements in Arctic exploration. After several seasons' patrol work in the western Canadian Arctic on the *St. Roch*, Inspector Larsen was instructed to prepare to make the North West Passage in 1940. That was a heavy ice year and other difficulties were encountered, so that he was obliged to winter twice before accomplishing the Passage in 1942, the first time it had been made from west to east.

In 1943 he left the Hudson Bay region on an attempt to make the Passage westwards by a more northerly route, if possible in one year, and this he succeeded in doing for the first time, in only eighty-six days, almost exactly one hundred years after the sailing of Sir John Franklin in the *Erebus* and *Terror*. The success of his two voyages is high testimony to Inspector Larsen's great skill as a navigator and his qualities of leadership.

I will now ask the acting High Commissioner for Canada, Mr. Hudd, whom we are very glad to welcome here to-day, to receive these medals on behalf of Dr. Camsell and Sub-Inspector Larsen, both of whom unfortunately are unable to be present this afternoon since they are once more in the northern territories, the field in which their work is now rewarded.

The HIGH COMMISSIONER FOR CANADA (Mr. Frederic Hudd): Mr. President, Ladies and Gentlemen, I esteem it a privilege to have been given the opportunity of receiving these medals on behalf of Dr. Camsell and Sub-Inspector Larsen, two Canadians who have rendered outstanding service in the realm of science and exploration. These awards are a recognition that the pioneer spirit in Canada still flourishes, and I think you may count upon finding Canada in the vanguard in the continued advancement of geographical science.

The PRESIDENT: The Founder's Medal for 1946, with the approval of His Majesty the King, has been awarded to Brigadier Edward A. Glennie, C.I.E., D.S.O., for his work on geodesy in India and his contributions to mapping in the Far East. Brigadier Glennie, as Director of the Geodetic Branch, has been responsible for much of the recent scientific investigation carried out by the Survey of India. He has contributed especially to the study of gravity anomalies with the purpose of ascertaining what evidence they afford on the composition and structure of the earth's crust, and he was the first to develop the theory of "crustal warping." During the war, as Director of Military Surveys, he was charged with the coordination of all military mapping in India and the Far East theatre, a field in which he has contributed greatly to geographical knowledge in its wider aspects.

Brigadier EDWARD A. GLENNIE: I thank you, Mr. President, and the Council of the Society for the very great honour which has been accorded to me by this presentation of the Founder's Medal. It will be a strong incentive to me to continue geodetic work so far as I can after I am retired. As Director of the Geodetic Branch in the Far Eastern theatre, my task was made easy by the untiring and successful efforts of all those in the military service and in the Survey of India who were engaged in the work. I therefore stand here as their representative and would like to thank you also on their behalf, Mr. President, for this recognition of the work done.

The PRESIDENT: The Victoria Medal, which is not awarded every year but only when an opportunity presents itself to mark especially distinguished work, is given by the Society for scientific research in geography. This year the Council have decided to award a Victoria Medal for 1945 to Professor H. J. Fleure, F.R.S., in recognition of his distinguished service in the advancement of geographical education and his valuable researches into the human aspects of geography.

As an archaeologist and anthropologist, Professor Fleure has brought an unusually wide knowledge and outlook to the study of man in relation to his geographical environment, and these sciences in turn have benefited from his contributions as a geographer. The combination is well illustrated in his 'Corridors of time,' written in cooperation with Dr. Harold Peake. His many studies on the peoples and human geography of Europe have promoted a truer understanding of present-day problems. The progress of geographical education in the universities and schools also owes much to his knowledge and enthusiasm, both as Professor of Geography and Anthropology at the University College of Wales and later at Manchester University, and as Hon. Secretary of the Geographical Association and Hon. Editor of its publication, *Geography*.

Professor H. J. FLEURE: Mr. President, it touches me very deeply that this great Society should recognize in a most generous way my efforts towards the

understanding of man in relation to his geographical environment. It will be a great encouragement to me to continue my work in that direction. I thank you for this evidence of the Society's cooperation.

The PRESIDENT: Lieut.-Colonel W. E. Browne, M.B.E., who is awarded the Murchison Grant for 1945, was for many years Chief Surveyor of the Anglo-Iranian Oil Company. His work during the war has been chiefly concerned with the unification of the geodetic survey system of Europe, in the course of which he has successfully solved the old and considerable problem of avoiding discontinuity at national frontiers. He has also invented, organized, and carried through a novel method of carrying triangulation across large stretches of water or desert, between stations which are not intervisible on the ground, by a radar-controlled system of simultaneous observation on to flares dropped from aircraft.

As Colonel Browne has been unable to return from the Bahamas for this meeting, I am asking your Hon. Secretary, Brigadier Sir Clinton Lewis, to receive the Award on his behalf.

The Murchison Grant for 1946 has been awarded to Lieut.-Colonel C. A. Hart for his work on the application of radar to air survey. Colonel Hart, now Assistant Director of Military Survey, has been closely associated with developments in the technique of air survey which has made great advances in recent years. Before the war he was senior lecturer in Civil Engineering and Survey at University College, London, and published an important work, 'Air photography applied to surveying.' During the war, he specialized in the application of radio science to air survey, and it is largely due to his work that the problems of determining the position of an aircraft at the moment of photography have been overcome.

Lieut.-Colonel C. A. HART: I deeply appreciate, Mr. President, the honour this Society has conferred upon me by the award of the Murchison Grant. I am glad that any contribution I have been able to make during the war to the advancement of military surveying has also had some small application to the development of air survey in the British Empire. The success of our experiments has been largely due to the cooperation we have received from the Air Ministry and the Ministry of Aircraft Production. I should like to pay my own personal tribute to the wonderful team that helped me during the experiments, and I feel that any award the Society has made to me is also a recognition of their work.

The PRESIDENT: The Council have awarded the Back Grant for 1946 to Mr. J. W. S. Marr for his work in connection with the *Discovery*, and his memoir on the South Orkney Islands.

Mr. Marr's long experience of the Antarctic began in 1921, when he was a member of Sir Ernest Shackleton's last expedition on the *Quest*. Since then he has served as a zoologist on the scientific staff of the Royal Research Ship *Discovery II*, during whose commissions so much knowledge of the geography and oceanography of the Falklands Island Dependencies has been gained. His memoir on the South Orkney Islands includes a valuable historical summary of the early surveys of this group, and a systematic description of its physical geography.

Mr. J. W. S. MARR: I thank you, Mr. President, for the great honour conferred upon me in recognition of my investigations with the *Discovery* and my work on the South Orkney Islands.

The PRESIDENT: Commander K. E. Oom, O.B.E., of the Royal Australian Navy, receives the Gill Memorial, 1945, for valuable service during the Pacific campaign. During the years 1942 and 1943 he personally carried out in the face of the enemy important surveys of the New Guinea coast between Cape Ward

Hunt and Milne Bay, which have added much to our knowledge of these waters. Later, as Head of the Australian Hydrographic Department, he was responsible for initiating and organizing similar important work in this theatre of operations. Commander Oom is at this moment engaged on survey work in the Pacific, and Lieut.-Commander Bryan, Australian Naval Liaison Officer in London, is here to-day to receive the award on his behalf.

Lieut.-Commander BRYAN: Mr. President, Ladies and Gentlemen, it gives me great pleasure to accept this award of the Gill Memorial to Commander Oom, and on his behalf to thank you for your kindness in making this award to an officer of the Royal Australian Navy.

The PRESIDENT: The Gill Memorial for 1946 has been awarded to Wing Commander D. C. McKinley, D.F.C., A.F.C., for his organization and leadership of the flights of the *Aries* to the North Magnetic and North Geographical Poles in May last year.

The achievements recognized by this award will be familiar to those who were present at Wing Commander McKinley's lecture in December. An experienced pilot and specialist navigator, he displayed great organizing abilities when the flights were being prepared at the Empire Air Navigation School. During the flight his numerous and arduous duties included flying the aircraft manually, in conjunction with his second pilot, for more than one hundred hours, and it was his determination which resulted in the resumption of the flight within two hours of the first unsuccessful attempt. To him are due therefore in no small degree the valuable scientific data gained on these flights.

Wing Commander D. C. McKINLEY: Mr. President, I feel deeply honoured by having been chosen as the recipient of the Gill Memorial for 1946. In accepting it, I do so in part for my crew, who had quite the most difficult part of the expedition. I am deeply interested in high latitude navigation and I hope that we may have an opportunity to repeat our flights and gather some of the information which we failed to get this time.

The PRESIDENT then delivered the Presidential Address, which is printed on pp. 81–89.

Visitors then withdrew and the PRESIDENT appointed Colonel Young and Mr. John Murray to act as scrutineers of the ballot for the Council and Officers for the ensuing year.

The PRESIDENT submitted the Annual Report of the Council which was adopted on the motion of the Rev. G. HOPPER, seconded by Dr. HUGH SCOTT.

The scrutineers informed the President that the list of candidates proposed as Council and Officers for the ensuing year had been elected (see list, p. v).

Major E. G. SCOTT: I should like to take the opportunity of expressing, Mr. President, what I am sure is the deep appreciation of all the Fellows of the Society to yourself for your Address, and to the staff of the Society for the admirable way in which they have carried on the work of the Society during the very trying years of the war.

The PRESIDENT: I am very much obliged to you for those remarks, especially for what you have said with regard to the staff. The amount of work they have put in during the past year is deserving of the highest praise. What you have said will be passed on to them, and I am sure it will be a matter of warm satisfaction to them all.

MEETINGS: SESSION 1945–46

Fourteenth Meeting, 4 March 1946. The President in the Chair

Elections: William Edward Arnell, B.SC.; Sub-Lieut. Reginald Bernard Baynes, R.N.V.R.; Major Basil Adam Buckwell, D.S.O., M.C., R.A.; Miss L. Burridge; Trevor Cleaton-Davies, B.A., L.C.P.; Major William Frederick Wybert MacLauchlan Clive; Captain Victor Howard Craven-Hodgson; David Davis; William John Evans; Captain Peter Reeder Finch, M.A.; Lieut. John Henry Hawkey, R.N.V.R.; Professor Bo Hellstrom; Reginald Crawshaw Honeybone; Sub-Lieut. Ioan Telford Hughes, R.N.V.R.; Neil Edgar Humphreys; Arthur Gilbertson Hutchison, PH.D.; Lieut.-Commander Wilfrid Bassil Johnston, R.N.V.R.; Gordon Herbert Joyner; Professor David Leslie Linton; Mrs. Dorothy Mary Mackay; The Rev. Ronald Metcalfe; Mrs. Kathleen F. M. Monier-Williams; Major Walter Windyer Morris, B.A.; Lieut. Norman Douglas Parker; Miss Rosetta Florence Phillips, B.SC.; Harry Praed; Robert Rees Rawson, B.SC.; Edward Rodwell; Charles David Torvell, B.A.; Miss Helen Margaret Wallis; Herbert Gordon Victor Walsh

Paper: The mulberry harbours. By Brigadier J. S. Rolfe

Fifteenth Meeting, 11 March 1946. Mr. Leonard Brooks, Vice-President, in the Chair

Geographical Films: Explorations of the Jungfraujoch research party. Geographical films with commentary by Mr. G. Seligman

Sixteenth Meeting, 18 March 1946. The President in the Chair

Paper: Present trends in population relative to biological resources, with special reference to the British Empire. By Dr. G. C. L. Bertram

Seventeenth Meeting, 25 March 1946. Brigadier Sir Clinton Lewis, Honorary Secretary, in the Chair

Paper: Air survey. By Lieut.-Colonel C. A. Hart

Eighteenth Meeting, 28 March 1946. The President in the Chair

Paper: Air photography and civil planning. By Squadron Leader T. D. Weatherhead

Nineteenth Meeting, 1 April 1946. The President in the Chair

Elections: Hugh Craven Andrews, B.A.; Miss Patricia M. Bailey; Ronald Gray Barker; Basil Birchmore, B.A., A.K.C.; Albert Fernleigh Bluett, M.A., M.B.E.; Marutrao Ramachandra Bobade; David M. Brown, B.A.; Eric H. Brown; John Henry Browne, F.R.ECON.S., F.R.A.S.; Arthur Hugh Carrington; Mervyn Sumpter Child-Thomas; Captain Adrian Maurice Trevor Twentyman Davis; Captain R. E. Donaldson-Rawlins; The Rev. Ernest Prior Egerton; Herbert Maxwell Findlater; Major Duncan Fraser, R.M.; Dr. Michael John Gilkes; Norman Adamson Harper; Stanley Harold Riseman Harris; Captain T. E. Hilton; Donald Hartley Hofford; Alan Edward Houseman; Clarence Kidson; Major Thomas William Kimpton, R.E.; Major Eric S. J. McCollin, B.SC., M.B., CH.B.; Captain Ronald Allan McInroy; Albert Olatunde Oshodi; Grahame Wilshaw Parker; Dr. John N. A. Pritchard; Albert Owen Richards; The Rev. Ralph R. Sadleir; John Hugh Saffery, D.S.O.; Leonard Francis Schuster; Major Edward Lionel Skelly; Raleigh Ashlin Skelton; Douglas Granville Stewart; Major F. Waugh, R.T.R.; Gilbert Alan White; George Burn Young

Paper: The geographical distribution of plants. By Colonel F. C. Stern

Twentieth Meeting, 8 April 1946. Mr. Leonard Brooks, Vice-President, in the Chair

Geographical Film: The island of Cyprus. Geographical film with commentary by Mr. R. Keene and Mr. L. Lee

Twenty-First Meeting, 15 April 1946. Professor L. Dudley Stamp in the Chair

Paper: Geography and planning. By Professor G. H. J. Daysh and Mr. A. C. O'Dell

Twenty-Second Meeting, 29 April 1946. The President in the Chair

Elections: The Hon. Mrs. Colin Forbes Adam; Eric Worton Battersbey; Major Bryan Bayly; Arthur Oliver Bray; Major John Brough, D.S.O., M.C.; The Rev. Vincent Bywater; James Allan Cash; Ernest S. E. Clark; F/Lieut. Michael James Burke Cole, D.F.C, R.A.F.; Sub-Lieut. William Jordan Coop, R.N.V.R.; Dr. Thomaz Oscar Marcondes de Souza; Major Denis Esmonde-White, M.C., R.A.; William Guerin Fitz-Gibbon, B.A.; Alfred Henry French; Herbert Gellatly, B.A.; Major J. T. Gleave, M.A.; Lieut.-Commander Basil Lawrence Jenkins, R.N.V.R.; Peter Gregory Johns; William Baxter Johnson; James Avery Joyce, B.SC.; Edward William Kenward; Lieut.-Commander James Lennox-King; John Patrick Macmillan; Ivan George William Marchant, B.SC.; Ronald Herbert Miller; The Rev. Thomas Hugh Moreton; The Rev. Arthur Leonard Morris; Philip M. Mortimer-Bayley; Rupert Singleton Pitt-Kethley; Clement Greville Smith; Samuel Victor Osmund Somanader; Mrs. Louisa Anne Thomson; Bert Watts; G. J. Williams; Philip Ernest Witham

Paper: Geographical problems in combined operations. By Commander N. C. Wilmot and Lieut.-Commander G E. Bingham-Powell.

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